Aviation Week

Including Space Technology

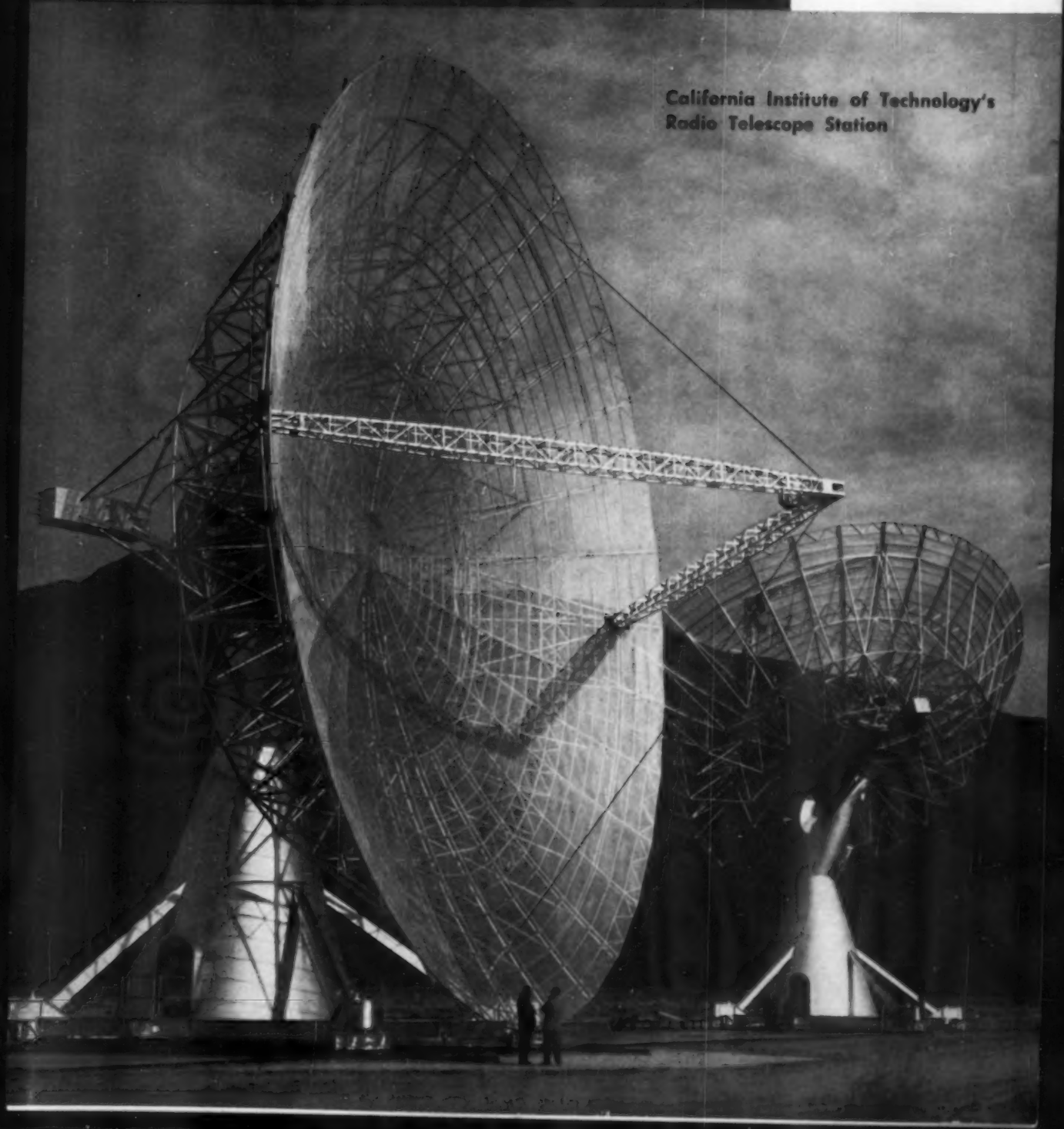
75 Cents

A McGraw-Hill Publication

May 25, 1959

SPECIAL REPORTS:

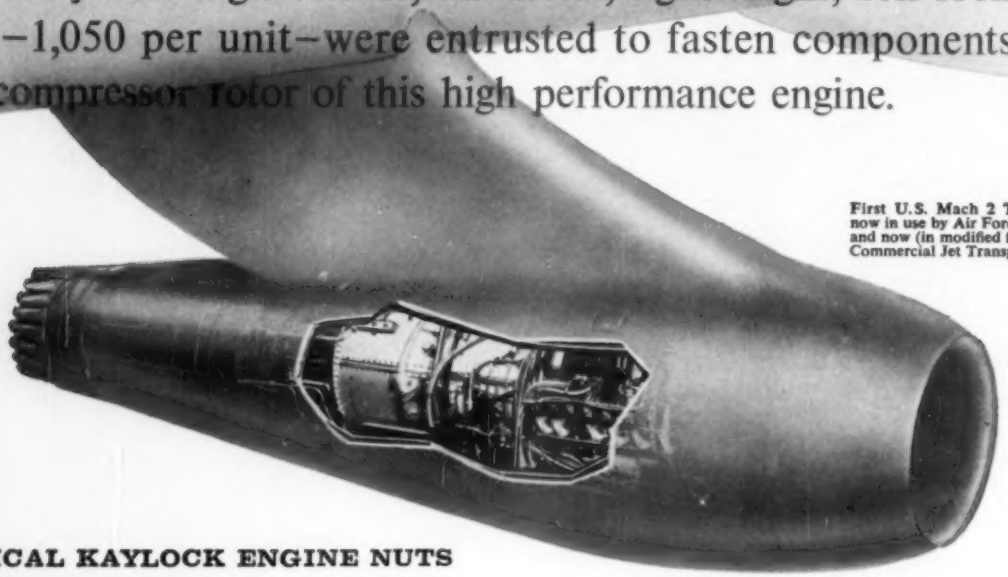
- **Atlas Bases**
- **Titan Testing**



California Institute of Technology's Radio Telescope Station

Kaylock nuts...built to "play with fire!"

America's most powerful Turbojet Engine points its nose at Mach 3. At these speeds, critical components endure enormous stresses. Fasteners must be built to literally *play with fire.* That's why Kaylock high tensile, all metal, lightweight, self-locking nuts–1,050 per unit–were entrusted to fasten components of the compressor rotor of this high performance engine.



First U.S. Mach 2 Turbojet now in use by Air Force, Navy and now (in modified form) on Commercial Jet Transports.

TYPICAL KAYLOCK ENGINE NUTS

K19060 K19061 K19062

K19063 K19064 K19066

RG5231 H33-5 H14

WHY KAYLOCK? Because only Kaylock nuts offer advantages every design engineer wants–

RELIABILITY –every thread carries its full load. Kaylock nuts have no weakening slots. No built in "stress raisers."

LIGHTER –Kaylock Jet Engine Nuts are approximately 50% lighter than old style nuts.

SMALLER –Kaylock nuts have smaller envelopes. Use smaller wrenches. Permit bolt center line to be moved closer to load.

SELF-LOCKING –Resilient, elliptical locking device maintains consistent self-locking torque. No sharp edged slots to cut into threads of mating bolt.

Have Fastener Problems?
Send for Kaynar's new 160,000 psi brochure. Our compliments, of course. Just fill in coupon below and mail to:

KAYNAR MFG. CO., INC.–KAYLOCK DIV.
Box 2001, Terminal Annex • Los Angeles 54, Calif.
Rush my FREE copy of the new Kaylock 160,000 psi brochure.

NAME _____ TITLE _____
COMPANY _____
COMPANY ADDRESS _____
HOME ADDRESS _____
CITY _____ ZONE ____ STATE _____

KAYLOCK
All-metal self-locking nuts ®
Trade Mark

KAYNAR MFG. CO., INC.—KAYLOCK DIVISION
Home office and plant: Write Box 2001, Terminal Annex, Los Angeles 54, California. Branch offices, warehouses and representatives in Wichita, Kansas; New York, N.Y.; Atlanta, Georgia. Canadian Distributor: Abercorn Aero, Ltd., Montreal, Quebec.

© KAYNAR MFG. CO., INC., 1959

• GUIDANCE
• NAVIGATION
• BOMBING

So Flexible, *it can be adapted to various type missiles, manned or unmanned aircraft—use star-field pattern for matching interplanetary guidance—*

So Uncanny, *it can be launched from barren areas where there are no fixed ground reference points and strike a precise target thousands of miles away—*

So Pinpoint Accurate, *it can hit its objective with a single missile—rather than needing a salvo.*

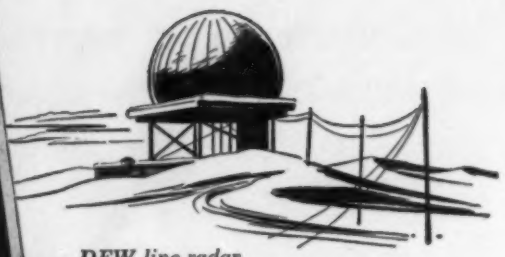
Pinpoint

—A PRIME CAPABILITY OF

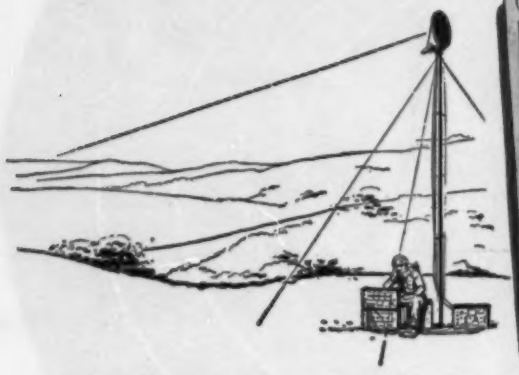
GOODYEAR AIRCRAFT

Pinpoint—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

Plants in Akron, Ohio, and Litchfield Park, Arizona



DEW line radar



Mobile microwave communication system

Storm detector radar

Electronic products of proven quality, efficiency and reliability for the Armed Forces

AVIATION CALENDAR

June 1-3—Third Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, University Heights, Bronx, N. Y.

June 1-3—National Symposium, Institute of Radio Engineers' Professional Groups on Microwave Theory & Techniques, Harvard University, Cambridge, Mass.

June 3-5—13th National Convention, Armed Forces Communications and Electronics Assn., Sheraton-Park Hotel, Washington, D. C.

June 4-5—Third National Conference, Institute of Radio Engineers' Professional Group on Production Techniques, Villa Hotel, San Mateo, Calif.

June 5-6—Annual Meeting of the Army Aviation Assn. of America, Shoreham Hotel, Washington, D. C.

June 5-6—10th Annual Maintenance & Operations Meeting, Reading Aviation Service, Inc., Municipal Airport, Reading, Pa.

June 8-11—Semiannual Meeting and Astronautical Exhibition, American Rocket Society, El Cortez Hotel, San Diego, Calif.

June 12-21—23rd French International Air Show, Le Bourget, Paris, France.

June 13-23—International Conference on Information Processing, UNESCO House, Paris, France.

June 14-18—Semiannual Meeting, American Society of Mechanical Engineers, Chase-Park Plaza Hotel, St. Louis, Mo.

June 16-17—Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, Mich. Sponsor: Michigan Aeronautics and Space Assn.

June 16-19—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

June 18-20—15th Annual Meeting, Institute of Navigation, U. S. Merchant Marine Academy, Kings Point, L. I., N. Y.

(Continued on page 6)

AVIATION WEEK Including Space Technology

May 25, 1959

Vol. 70, No. 21

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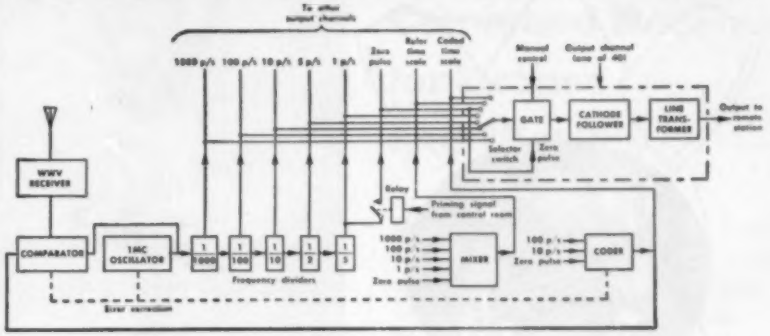
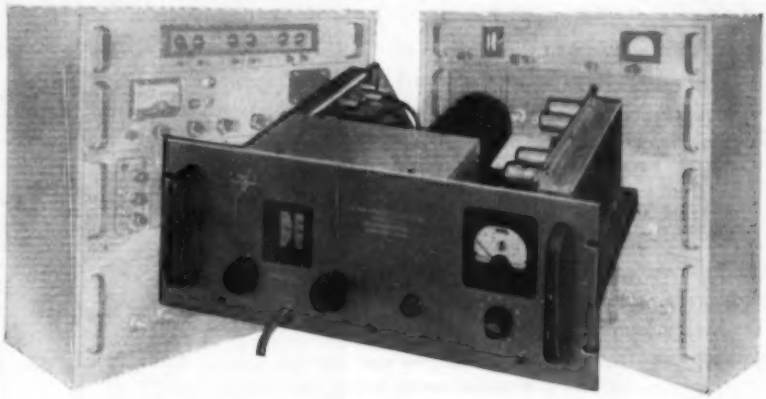
AN INTEGRATED TIMING SYSTEM FOR TRACKING AND CONTROL OF MISSILES



Schematic diagram of Central Timing Station



The Hycon Eastern Integrated Timing System, when used as a central station timer, meets the requirements of most range instrumentation with one comprehensive unit. At pre-programed times during the shoot, time markers are supplied to recording instruments and switching pulses are supplied to recording and control instruments located in remote slave stations.

At the heart of the Timing System is the Hycon Eastern Ultra Stable Oscillator with guaranteed stability of one part in 10^9 and even greater stability in actual practice. A WWV Receiver corrects for drift error of the time base oscillator over long time periods and a time scale is available with resolutions accurate to 1 microsecond

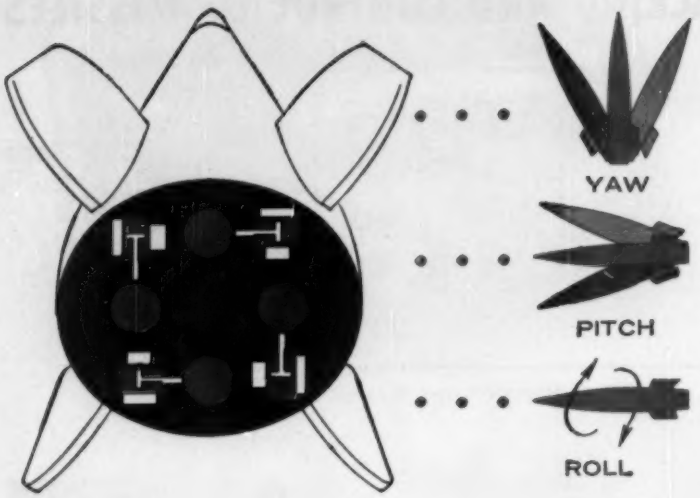
Solar or sidereal time is displayed visually and is available for both input to automatic computers and as an index to data being recorded during the test run. Capable of operating anywhere in the world, this system is also suited for astronomical measurements and navigation systems. Write for Bulletin TS-00.

Tomorrow's Timing Systems . . . Today

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. W Cambridge 42, Mass.

in rocket-engine and missile testing . . .



CompuDyne NOZZLE ACTUATION CONTROL SYSTEMS

GIVE ACCURATE IN-FLIGHT DATA—ON THE GROUND!

Missile engineers can get a profitable rocket run for their time and money with a new, CDC-developed Nozzle Actuation Control System.

Utilizing computer-controller techniques and high-speed, high-force, electro-hydraulic actuators, the system permits accurate, dynamic testing of nozzle seals, structural integrity and the dynamics of the missile gimballing system during static engine tests. With "push-button" convenience, a tape-fed programmer issues pitch, yaw and roll control correction signals as they might occur in the course of actual missile flight. The system's positional resolution and repeatability are better than one part in 1000.

Delivered as a complete, performance-guaranteed package, this CompuDyne Control System is one of many dynamic test systems developed by CDC for the aircraft, missile, and rocket industries. Included are systems for Rocket Fuel Control, for Structural Loading of Airframes, for Blowdown and Continuous Wind Tunnels. Diverse in function, the systems have one thing in common: they have all been built upon a broad base of theoretical knowledge coupled with practical experience in the very specialized field of dynamic control.

For further information on CompuDyne Control Systems for missile and rocket testing, write, wire or telephone.

Representatives in Major Cities

CompuDyne Corporation

(Formerly CDC Control Services, Inc.)

Manufacturers of Computer-Dynamic Process Control Systems

401 S. Warminster Road, Hatboro, Penna.

c.A. 1931

AVIATION CALENDAR

(*Continued from page 5*)

June 21-26—Summer-Pacific General Meeting and Air Transportation Conference, American Institute of Electrical Engineers, Olympia Hotel, Seattle, Wash.

June 23-25—33rd Meeting, Aviation Distributors and Manufacturers Assn., St. Francis Hotel, San Francisco, Calif.

June 24-26—Second National Symposium, Nuclear Industry Division, Instrument Society of America, Idaho Falls, Idaho.

June 29-July 1—Third National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C. Sponsor: Institute of Radio Engineers' Professional Group on Military Electronics.

June 29-July 3—Summer seminar on Plastics—Its Mechanical Properties, Design and Applications, Pennsylvania State University, University Park, Pa.

July 1-10—U. S. National Soaring Competition, Harris Hill, Elmira, N. Y.

July 4-8—All-Woman Transcontinental Air Race from Lawrence, Mass., to Spokane, Wash. For information: All-Woman Transcontinental Air Race, Inc., 2611 East Spring St., Long Beach 6, Calif.

July 16-17—Third biennial joint meeting, Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

July 28-29—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Westward Hotel, Anchorage, Alaska.

July 30-31—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Fairbanks, Alaska.

July 30-31—Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute, Stanley Hotel, Estes Park, Colo.

Aug. 4-5—Second Annual Western Regional Meeting, American Astronautical Society, Ambassador Hotel, Los Angeles, Calif.

Aug. 5-7—William Frederick Durand Centennial Conference on the problems of hypersonic and space flight, Stanford University, Stanford, Calif.

Aug. 17—First National Ultrasonics Symposium, Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.

Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.

Aug. 24-26—Gas Dynamics Symposium, American Rocket Society, Northwestern University, Evanston, Ill.

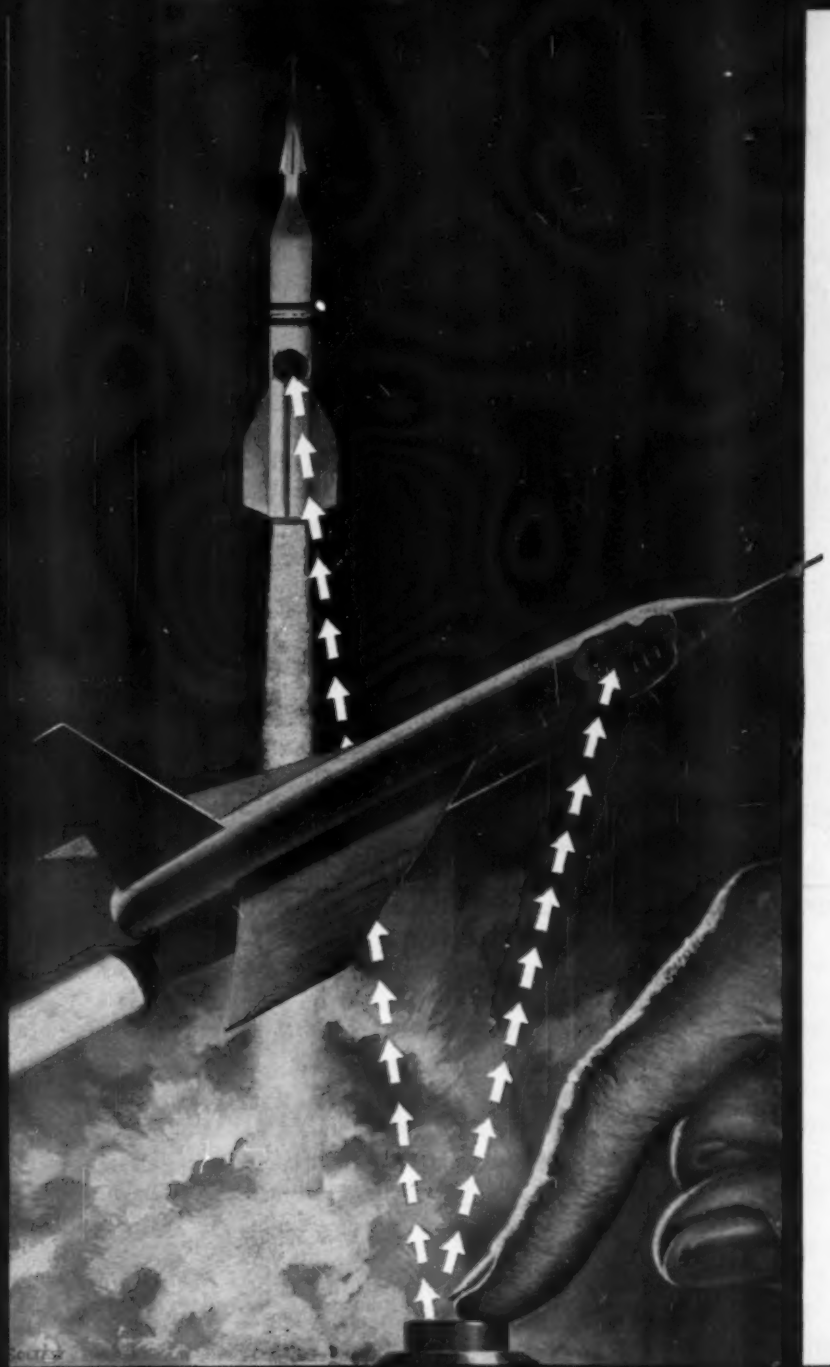
Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 16-17—1959 Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.



From Crosley...

Command Receivers for Drones and Missiles

Designed and manufactured by Avco's Crosley Division, Command Receivers are standard equipment aboard most of the nation's missiles. Their job: To receive and act upon instructions from the ground to destroy the missile when its flight path indicates the missile has gone awry.

In a missile configuration, the Command Receiver weighs only 12 pounds, has three channels and incorporates a decoder and power supply in a simple pressurized package.

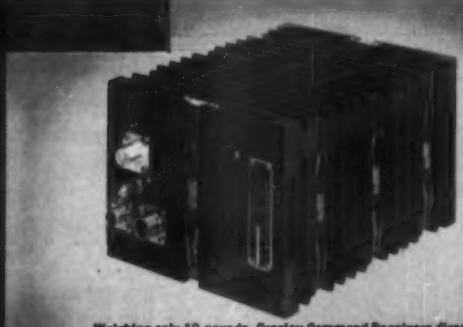
A second version of the Command Receiver, employing 12 channels for radio communication, is used in high-performance drones and decoys. In such applications, the Command Receiver actuates control surfaces, directs engine operation and opens the recovery parachute—all by radio-conveyed instructions from the ground.

A Product of Crosley Engineering, the Command Receiver has proven itself for the future by the job it is doing in the missiles and drones of today.

For more information, write to: Vice-President, Marketing-Defense Products, Dept. W-59, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

Unusual career opportunities for qualified scientists and engineers . . . write Avco/Crosley today.

Avco / Crosley



Weighing only 12 pounds, Crosley Command Receivers direct destruction of off-course missiles, control drone recovery.

XX

This is the twentieth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Flame-Hardening Alloy Steels

When the surface of steel is subjected to direct application of flame and heated above the transformation range, then hardened by quenching, the process is known as flame-hardening. Its primary purpose is to surface-harden without affecting core properties. Jets of flame are played directly on the steel, and hardness penetration can be made to vary considerably. Usually in alloy steels this depth will range from 0.03 to 0.12 in., the actual figure depending upon the method of heating and quenching used.

Unlike carburizing, flame-hardening does not involve the absorption of extraneous elements by the steel. There is no alteration of the chemical composition. To put it simply, the steel must have its own self-hardening characteristics; cannot be dependent upon carbonaceous salt baths, gases, etc.

Flame-hardening is not a substitute for the conventional furnace method. Each has its uses. The particular virtue of flame-hardening is that the flames can be directed to localized areas. The furnace, on the other hand, is generally more economical and feasible when parts produced in large quantities must be hardened all over.

Any type of hardenable steel, alloy or carbon, can be flame-hardened, and there will usually be no scale or pitting. The alloy content is the governing factor when determining the quench. In some cases a rapid quench is required; in others, it can be as slow as air-cooling. Tempering presents no problems, for flame-hardened steel can be tempered as if hardened to the same point by other methods.

A list of typical flame-hardened parts would include such familiar items as gear and sprocket teeth, and certain types of cams and rollers, shoe treads, etc. This list is by no means exhaustive; it could include many other parts that often require a localized hardening treatment, especially for wear-resistance.

When seeking information about flame-hardening methods, please feel free to consult with our technical staff. Bethlehem metallurgists will gladly cooperate, and you can depend upon their suggestions. You can rely on Bethlehem, too, as a source of alloy steels, for Bethlehem makes the complete range of AISI standard grades, as well as special-analysis steels and all carbon grades.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

First with commercial trans-ocean jet service using U.S.-built planes, Pan American has halved flying time between world capitals and other major cities. The 600-mph-and-up speed at which Boeing 707 jets fly, accents the need for top reliability of air-navigation, radio, other electronic equipment . . . and all tubes and components.

Says: G. F. SHEPHERD, Foreman—Component Overhaul, Pan American World Airways System

"Our fast jet flights call for the dependable performance 5-Star Tubes like this give!"

"It's the second hand of your watch that ticks off the miles when you travel in Pan American's big jet planes. To maintain our fast schedules, pilots and co-pilots are guided by electronic equipment of the most advanced type now available.

"A 'something extra' guards the reliability of this equipment . . . G-E 5-Star Tubes. We've used them for many years in our piston planes. We know they're dependable, know they will outperform and outlast regular receiving tubes.

"They're manufactured for the needs of the new super-swift air age. So . . . Pan American employs General Electric 5-Star high-reliability tubes in critical sockets, to make jet travel still safer, surer, more punctual."

* * *

See your nearby General Electric tube distributor for 5-Star types! He gives "jet" delivery service! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Kentucky.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

2-311-102

Understandably unwelcome in King Cold's domain . . .

Heating Blankets and other Woven Heating Elements by SAFEWAY can make your COLD problems OLD problems!

Be it the frigid altitudes at which manned aircraft fly, the cold, trackless space domain of missile and satellite, or the icy arctic wastes of DEW Line installations — it's always "winter" somewhere.

Environmental temperature problems common to this kind of "winter" beset fuels and lubricants and hamper the operation of many types of sensitive equipment.

But SAFEWAY dispels such problems by packaging *controlled heat* for application *everywhere.* Among the wide variety of heating blankets and woven-wire heating elements which have been engineered by SAFEWAY to meet exacting specifications are:

- **heating elements for launching equipment and for airborne gyros, cameras, computers, servos and batteries — for missiles or aircraft**
- **de-icing units for airfoil surfaces**
- **heating elements for all types of ground support equipment**
- **defrosting units for industrial and commercial refrigeration**
- **heating blankets for honeycomb and metal-to-metal bonding**

For your copy of a fact-filled folder, please write:

If it has to be heated (and the "it" can be just about anything), you can rely on SAFEWAY engineers to study your problems carefully, and — without any obligation — submit an appropriate recommendation.

Safeway HEAT ELEMENTS INC.

680 Newfield Street • Middletown, Connecticut

SYSTEM RELIABILITY ASSURED

WITH MAGNETIC AMPLIFIERS, INC.

SOLID STATE-STATIC PROGRAMMER

Programmer equipment which provides a flow of unerring functional commands—accurately spaced in time—is mandatory for successful operation during the critical count down phase of missile launching.

The Automatic Sequencer shown utilizes a Stat-pack® system and accomplishes precision timing, switching and verification.➢➢ Sequential count down commands are initiated by the Timing Unit, capable of counting down from 999 seconds in 0.1 second intervals with an accuracy of 1%.➢➢ The Switching unit picks off the time points, and employs Stat-Pack® magnetic switches to control 27 functions—at 20 watts output per function. Visual display is provided for Initiate and Response for each function.

Automatic monitoring of each function is accomplished by the Verification Unit. It provides response signals for recognition of compliance for each function, and will halt sequential commands upon non-compliance. The Automatic Sequencer is the latest addition to Magnetic Amplifiers, Inc. proven group of Solid State—Reliability Assured Systems.

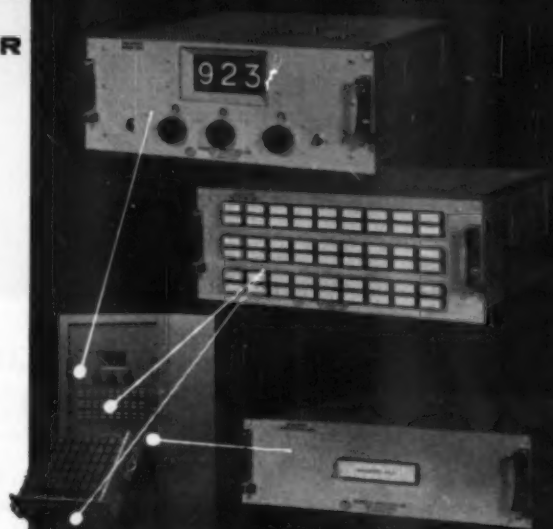
MISSILE CHECKOUT EQUIPMENT

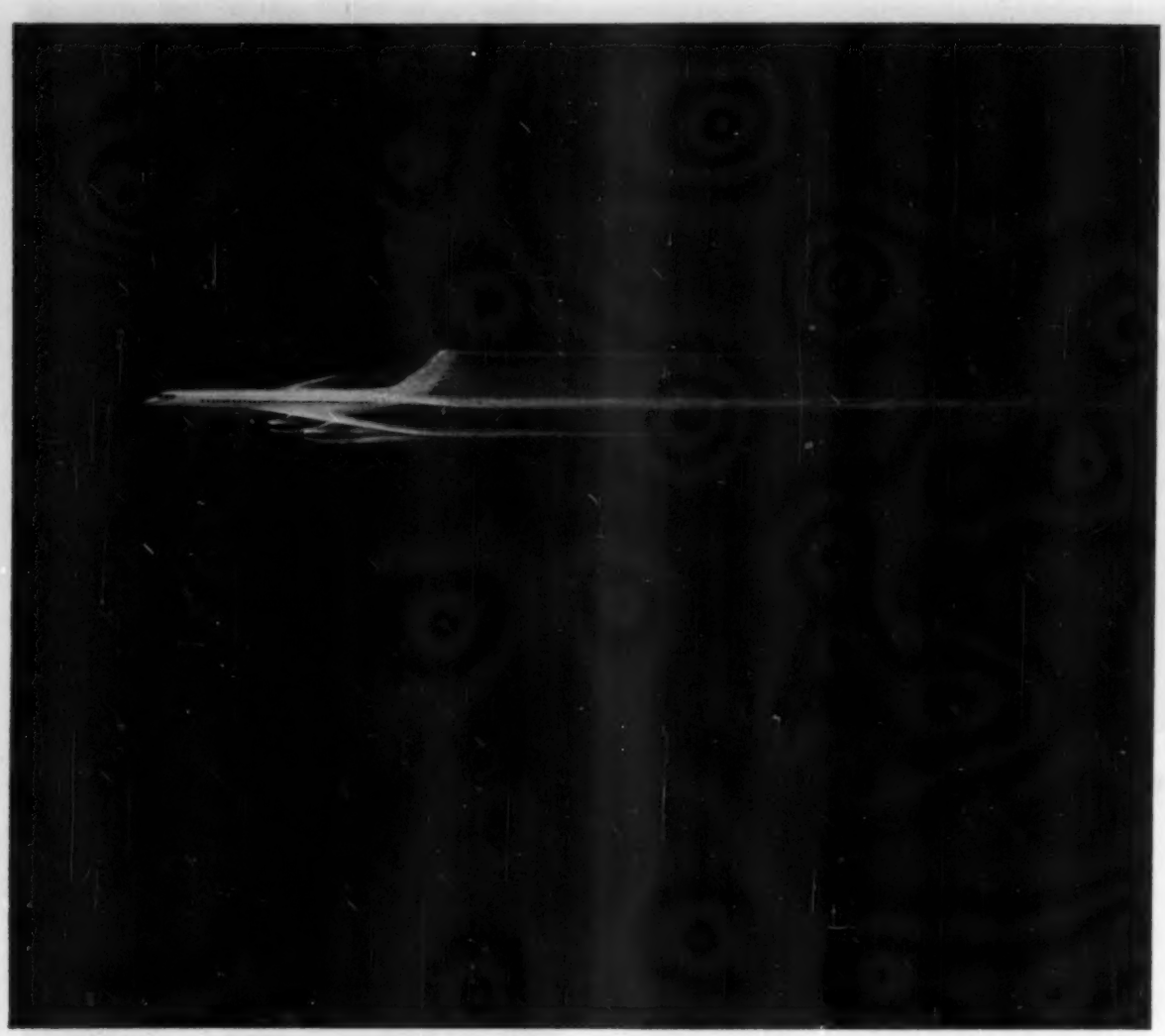
SIMULATORS

STAT-PACK® SWITCHING SYSTEMS

SPACE AND SUBMARINE AUTOPILOTS

®Registered Trademark





Engineering aircraft components to meet the needs of modern speeds

More strength and efficiency with less weight . . . that's the story of the ever-increasing demands in today's and tomorrow's aircraft performance requirements.

Through vigorous design research, and constant developments in structural concepts and materials, Rohr engineers are keeping up with . . . and ahead of these demands in the production of aircraft components.

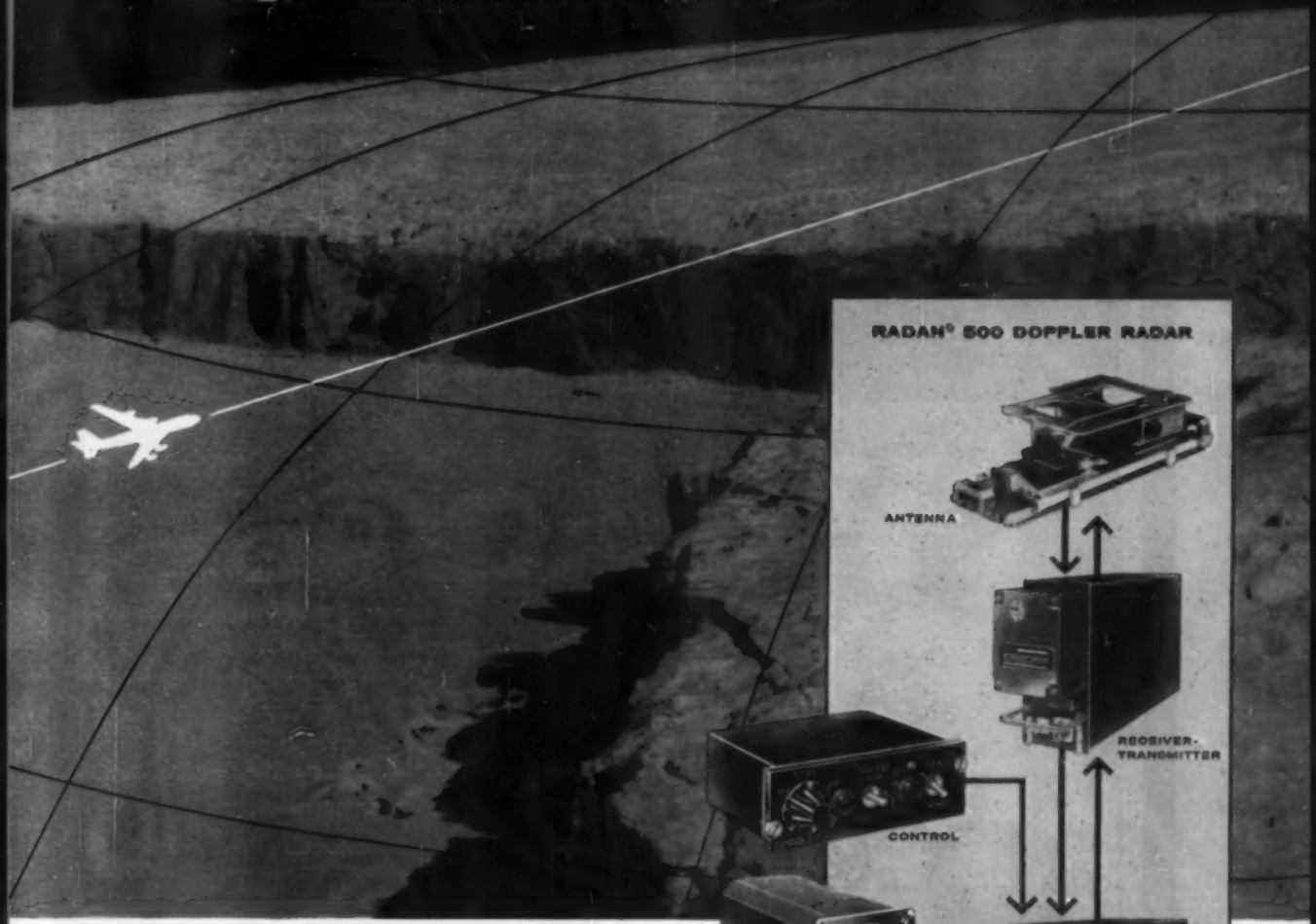
It's another reason for Rohr's position as leader in the design and production of major components for flight.

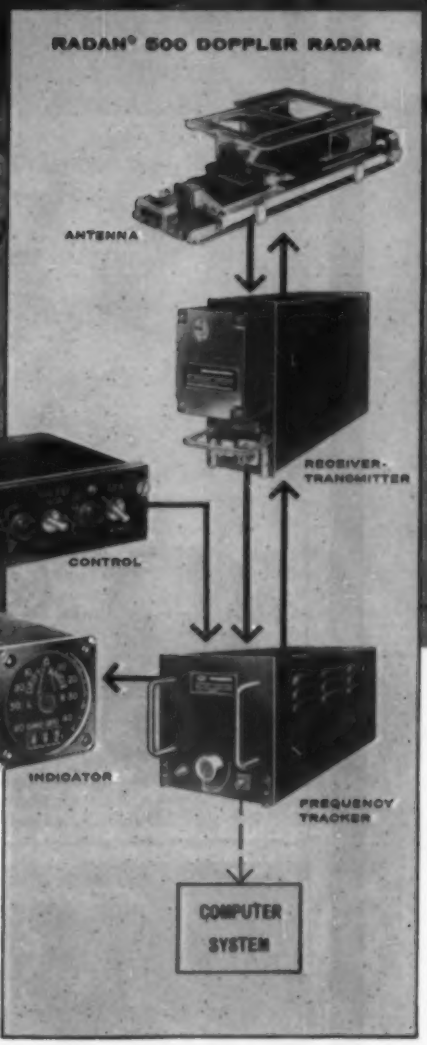
ROHR
AIRCRAFT CORPORATION

MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF.; PLANT: RIVERSIDE, CALIF.; ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.

Reliable RADAN 500

GPL's new commercial Doppler system





RADAN 500 Doppler radar, GPL's all new ARINC system for airlines, offers the reliability and longevity of service that only 13 years of direct Doppler experience can insure...reliability resulting from **flight-proven** designs based on 10 years of product improvement programs, service feedback on more than 1,500 operational GPL Doppler systems, and special attention to the design and maintenance philosophies of commercial airlines.

SELF-CONTAINED: Ground speed and drift angle, displayed directly, continuously, and accurately — over the poles, over oceans, over any terrain, day or night, good weather or bad — provide a dramatic extension of airline capabilities and important operational savings.

VERSATILE: Outputs for navigation computers, flight directors, autopilots, remote indicators, and attachments. Write to the world's most experienced Doppler manufacturer for further details on RADAN 500.

APPLICATIONS ENGINEERING

SERVICE FACILITIES

SPARES INVENTORY

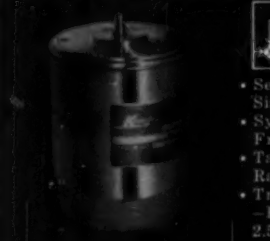
GPL | A GENERAL PRECISION COMPANY

GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y.

A Subsidiary of General Precision Equipment Corporation

BASIC BUILDING BLOCKS

SERVO SYSTEM COMPONENTS



- Servo Motors—Frame Sizes 5-25
- Synchros and Resolvers—Frame Sizes 5-25
- Tachometers—Damping, Rate, Integrating
- Transistorized Amplifiers—High Temperature 2.5-16 watts

Synchros—Size 25—20 sec. max. error

HYDRAULICS

6100 Series Servo Valve

Servo Valves

- Two moving parts
- Anti-clogging—over size orifices, high pressure clearing
- Flow rates—0-5, 0-10 gpm

Systems

For hi-performance hydraulic or pneumatic missile control.

COMPUTERS

Navigational Computer

- Great Circle Course and Navigational
- Inertial Position
- Guidance
- Analog and Digital for Missile Applications

INERTIAL GUIDANCE

25 lb. Inertial Platform

Components include floated gyros, single and two-axis accelerometers, first and second integrators, computers. Complete systems in production for major missile applications feature high accuracy, long-term reliability, light-weight construction.

GYROS

Miniature Floated Gyro

- Rate-floated Integrating; Spring Restrained
- Vertical—Miniature, Self-Contained
- Two Axis Free For Missile Control
- Directional, Conventional and Roll Stabilized
- 3 Gyro, 3 and 4 Gimbal Platforms
- North Seeking Theodolites

GROUND SUPPORT

Digital Logging System

Completely integrated ground support equipment based on unique Kearfott test equipment modules for analog or digital, manual, semi-automatic or fully automatic testing of components, sub-systems or systems.

MICROWAVE

Antenna Array

- Waveguides, Strip Transmission Lines, Ferrite Components
- Radar rf and Antenna Assemblies
- Transponder Systems, Target Simulators, Test Sets
- Traveling Wave Assemblies

Engineers:

Kearfott offers challenging opportunities in advanced component and system development

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1500 Main Avenue, Clifton, N. J.
Midwest Office: 23 W. Calendar Avenue, La Grange, Illinois
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, California

More than 450 different parts are now available from stock in the new Marman warehouse.

With the completion of a new warehouse, Marman has initiated a unique inventory program for off-the-shelf delivery of many types of Marman Products.

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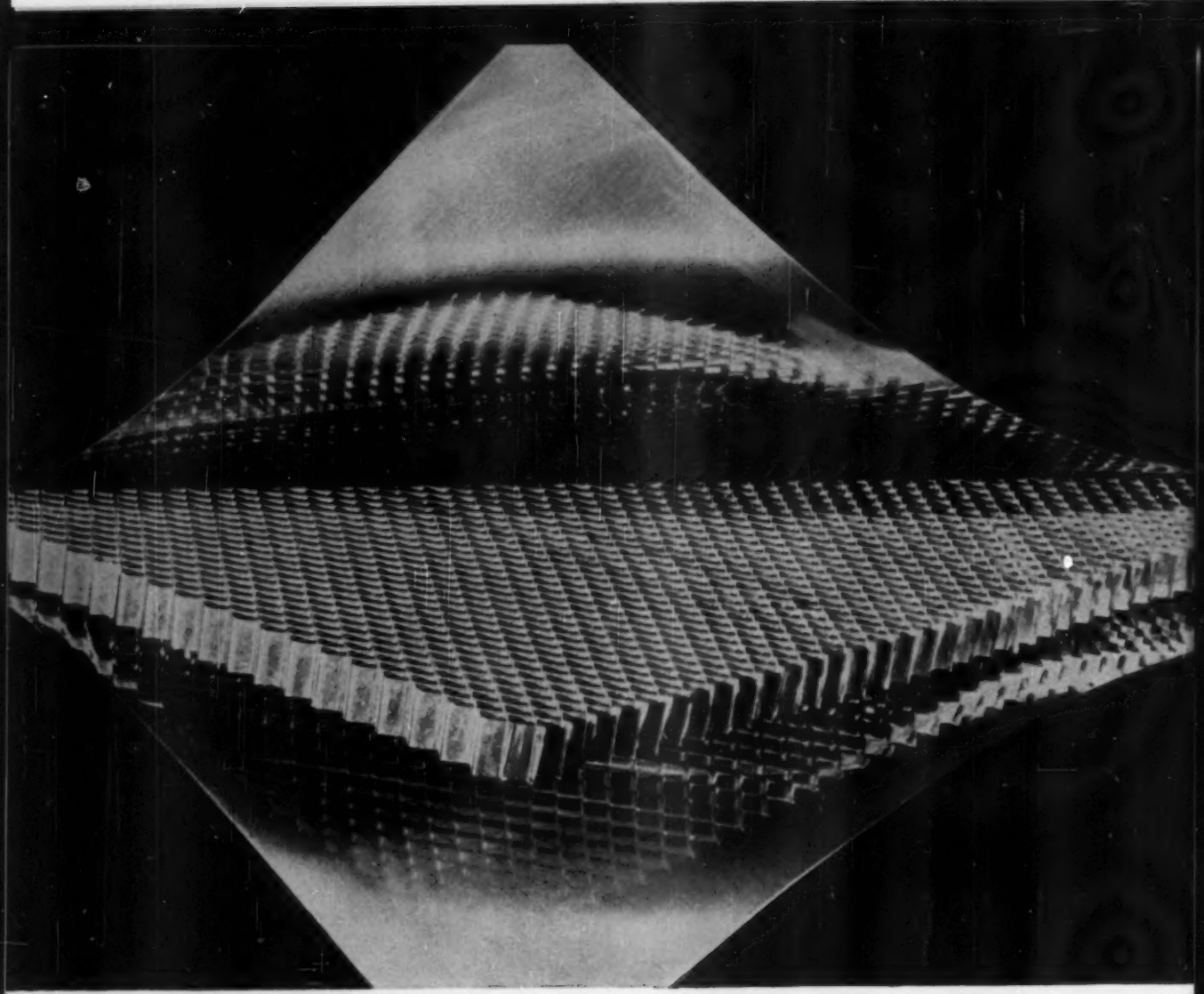

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COVER: California Institute of Technology's radio telescope station is in Owens Valley, six miles north of Big Pine, Calif., which is 250 mi. north of Los Angeles. The twin 90-ft. radio telescope dishes are mounted on tracks and can be brought in close proximity or moved as far as 1,600 ft. apart. The $1.5 million installation, which is used to make interferometry measurements, is operated by California Institute of Technology for the Office of Naval Research.

PICTURE CREDITS

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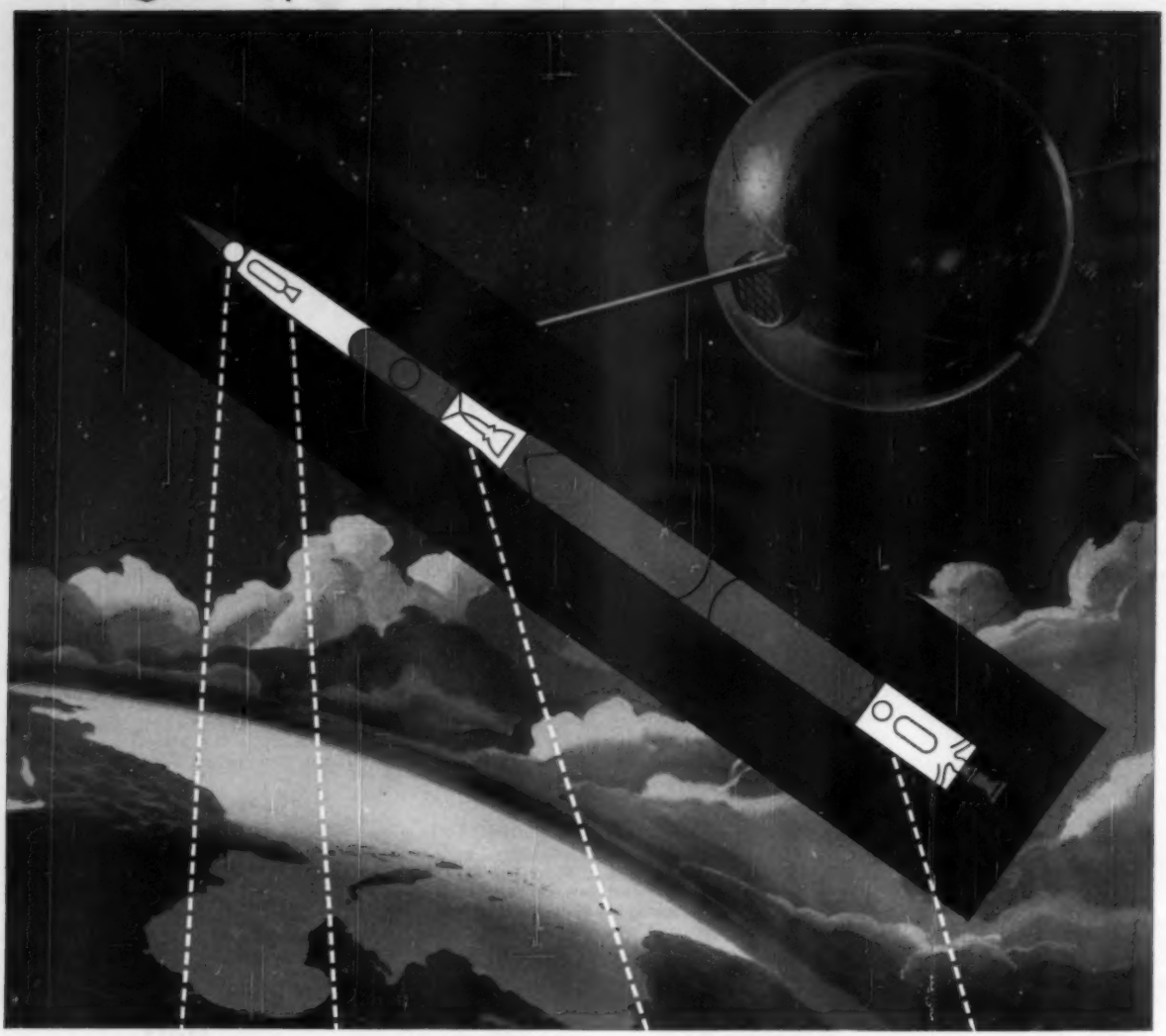

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EDITORIAL

Canadian Aviation's Fifty Years

Canadian aviation is marking its fiftieth anniversary this year. The first aircraft in Canada lifted off the frozen lake surface at Baddock, Nova Scotia, on Feb. 23, 1909. This Silver Dart biplane piloted by J. A. D. McCurdy was significantly the product of a joint Canadian-U.S. venture that established a pattern of cooperation that still holds true today. It was in 1907 that Alexander Graham Bell founded the Aerial Experiment Assn. with Canadians McCurdy and F. W. "Casey" Baldwin and, from below the border, Glenn Curtiss and Lt. Thomas Selfridge on leave from the U.S. Army.

This was the beginning of the Canadian aircraft industry that today is the third largest industry in the Dominion, employing about 35,000 people and ranking ninth in value of goods and services produced.

Canada contributed its share of top World War I fighter aces. Ten of the Royal Air Force's 27 leading aces were Canadians, and the names of Billy Bishop, Raymond Collishaw, W. G. Barker and Roy Brown embroider the legends of air combat in the canvas, wire and spruce era.

Between wars, Canadian aviation played a significant role, as it still does, in opening up the natural resources of the vast northern reaches.

The Canadian "bush pilot" with his pontoons and skis making landing fields of the myriad wilderness lakes was the pioneer prototype of all subsequent endeavors to pry open inaccessible territory from the air. Today, Canadian aviation operators, many of them little known outside their immediate areas, are performing spectacular jobs in routine fashion where nothing but airborne vehicles can operate. These jobs include the aerial supply of the DEW and mid-Canada radar networks; the suppressions of the budworm blight that saved a multi-billion-dollar paper pulp crop in New Brunswick; the construction of a railroad by air supply to tap the Labrador iron deposits; the construction of electric power lines by helicopter to harness hydraulic power to aluminum production in British Columbia, and the routine transport of people and goods in all kinds of weather that keeps the Canadian north and west on an operating economy.

RCAF Growth

During World War II, the Royal Canadian Air Force grew to a strength of 206,000 men and women and put 47 squadrons into combat operations overseas. Today, it provides an air division of jet fighters with NATO and is linked with USAF, Navy and Army units in the North American Air Defense Command, with RCAF Air Marshall C. R. Slemmon as vice commander of this joint enterprise. In tackling the air defense of the North American continent from supersonic aircraft and hypersonic missiles, the interests of Canada and the U.S. are inexorably intertwined.

As is so often the case in aviation, what was originally scheduled as a year of celebration for Canadian aviation has also turned into a year of crisis and question as to the future direction both the RCAF and the industry that supports it will take.

The fine production record of the Canadian aircraft industry during World War II and its post-war performance have demonstrated an ability to compete successfully in the international market in a variety of ways.

For bush-type transports with short field landing and takeoff requirements, it has been hard to surpass the de Havilland Canadian line of Beaver, Otter and Caribou.

In the art of adapting both British and American basic designs and adding a touch of its own that gives them distinctive performance, Canadair has an impressive post-war record with the Sabre jet fighter series using the Canadian-designed and built Orenda engine, the Argus anti-submarine patrol plane and now the CL-44 freighter which recently found a market among U.S. cargo lines.

The Avro Aircraft and Orenda Engine divisions of the British Hawker Siddeley group have struck out boldly on new designs with the Mach 2 Arrow all-weather fighter, the flying saucer and the tremendous Iroquois turbojet. But the Canadian defense budget has found it difficult to support the mounting costs of any new research and development program in the aerial weapons field. It is indeed fortunate that USAF has continued to support the Avro flying saucer project so that the validity of its principles can be determined by experimental performance.

Possible Course

In view of the astronomic costs of modern research and development in the areas of supersonic aircraft, missiles and space vehicles, Canada's wisest course may be to develop cooperative programs with both Britain and the U.S., where the results of this basic research, development, design and testing can be applied to fairly well proven hardware adapted to meet Canada's specific defense and transport requirements. And, where U.S. hardware such as the Bomarc air defense missile is purchased for Canadian use, it is obvious that Canadian industry must be given an opportunity to compete fairly for the subcontracting and supply business associated with the weapon system. We suspect that Canadian industry will have to be considerably more aggressive on an individual basis to make adequate progress in this area.

One irritating point in this picture of the aviation business on both sides of the border is the 12½% duty the U.S. imposed on Canadian-built aircraft sold here. There is no similar Canadian duty on U.S. aircraft sold north of the border, and we fail to see any valid reason for the continuance of this unreciprocated measure.

Just as 50 years ago U.S. and Canadian citizens joined in the Aerial Experiment Assn. to lay the foundations of flying north of the border, so today they must both continue to work together for the defense of the North American continent and the continued development of its sound and expanding economy.

—Robert Hotz

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WHO'S WHERE

In the Front Office

Charles E. Bartley, president, Rocket Power, Inc., Mesa, Ariz., recently organized subsidiary of The Gabriel Co. Mr. Bartley formerly was president of Grand Central Rocket Co. Also: **Frank A. Marion,** executive vice president of Rocket Power.

Stephen M. Jenks, executive vice president-engineering and research, United States Steel Corp., Pittsburgh, Pa.

G. T. Willey, vice president and general manager of The Martin Co.'s Orlando, Fla., division, succeeding E. G. Uhl who will return to the company's corporate staff at Baltimore, Md.

Gordon S. Burroughs, vice president in charge of the Military and Industrial Electronic Systems Department, CBS Laboratories, Stamford, Conn.

R. C. Chilton, vice president-development planning, Horkey-Moore Associates, Torrance, Calif.

Richard T. Orth, vice president-planning, Eitel-McCullough, Inc., San Carlos, Calif.

David B. Nichinson, vice president-engineering, Kollsman Instrument Corp., Elmhurst, N. Y.

Dr. Jerry McAfee and **Gen. K. D. Nichols** (USA, ret.), of Gulf Oil Corp., directors of Callery Chemical Co., Pittsburgh, Pa.

William P. Sloan, manager of Ryan Aeronautical Co.'s Washington, D. C., office. **Vice Adm. Charles F. Coe** (USN, ret.) will assume new duties in the Washington office as executive advisor to the vice president-military relations and military consultant to Mr. Sloan.

Chester Spurgeon, acting chief of the Office of Public Affairs, Federal Aviation Agency, Washington, D. C. Also: **Lucius W. Burton,** acting director of the new Bureau of National Capital Airports.

Dr. Bruce H. Billings, formerly vice president and director of Baird-Atomic, Inc., appointed assistant director of research and engineering, Department of Defense. Dr. Billings will be in charge of Special Projects, reporting directly to Dr. Herbert F. York.

Honors and Elections

Maj. Gen. Joseph D. Caldara, director of flight safety research for the Air Force, has received the Monsanto Aviation Safety Award for 1958 for having made the year's "most significant and lasting contribution to aircraft operating safety."

Peter Masefield, managing director of Bristol Aircraft, Ltd., has been elected president of the Royal Aeronautical Society, succeeding Sir Arnold Hall, chief executive of Hawker Siddeley, Ltd.

Changes

Conrad Kunze, assistant to **A. C. Esenwein,** executive vice president of Convair Division of General Dynamics Corp., San Diego, Calif. He will coordinate engineering and production methods in Convair's four operating divisions. **Wilbur E. Emish** succeeds Mr. Kunze as manager of industrial engineering at Convair-Fort Worth.

(Continued on page 135)

INDUSTRY OBSERVER

▶Watch for an announcement soon of a licensing agreement between Rolls-Royce, Ltd. and the Allison Division of General Motors Corp. for manufacture of the R.B. 141 bypass engine in this country. R.B. 141 is in the 12,000 lb. thrust class and is slated for use in the de Havilland 121 medium-range jet airliner. Biggest U. S. interest in the Rolls-Royce R.B. 141 is for possible application in the Douglas DC-9 medium-range jet transport design.

▶Martin Co. has designed a lunar housing simulator that would allow studies of men and equipment under conditions similar to those they would encounter at a moon base. Outer chamber would simulate space environment, allow study of techniques for transferring between free space and the artificial lunar environment.

▶Soviet development of feeding methods for use in space capsules includes a mixture of liquefied meats and milk products with the consistency of a thick chocolate malted milk and carried in a can with a tube attached. Another mixture of ham, cheese and bread has been reduced to the consistency of toothpaste and is carried in a squeezable tube.

▶Swiss air force technical decision on new equipment is expected within the next two months. Evaluation teams of pilots and technicians have just completed testing the Dassault Mirage 3, last of a series of aircraft flown and evaluated. Possible contenders include the Swedish Saab Draken, Italian Fiat G.91, Grumman F11F-1F Super Tiger and the Lockheed F-104. Reports are that tests of the Mirage were highly favorable.

▶Navy is considering the General Electric 2,570 shp. T64 turbine engine as a possible powerplant for an aircraft to fit into its "slow-plane" concept and provide a platform for the Eagle long-range air-to-air defense missile now under development. T64 also may be used by Navy in an STOL version of the Grumman S2F search plane.

▶Reaction control simulator for research and training of space pilots has been designed by the Martin Co.'s Denver Division. Spherical chamber riding on air bearings would house a space pilot and his controls. Chamber could be spun in any direction to learn what degree of disorientation pilot could withstand and still correct his attitude.

▶Air Force plans to refit some of its Lockheed RC-121 Airborne Early Warning and Control aircraft with new higher-power radars to extend the effective range of its SAGE air defense radars for guiding long-range Boeing Bomarc B interceptor missiles and North American F-108 interceptors. Prospective bidders for the program, known as Airborne Long-Range Input, or ALRI for short, received an Air Force briefing on the project last week at Wright-Patterson Air Force Base.

▶Watch for more insurance company funds to go into loans to the aviation industry. Significance is that only relatively limited amounts of insurance money are available for industrial lending, and such a loan implies confidence by the long-term insurance lender in the future growth and stability of the field. New loans by insurance companies in the last few months include $7 million in 5¼% notes issued by Thiokol Chemical Corp. and $75 million in the 20-year-notes of General Dynamics Corp. Ryan Aeronautical Corp. also has just arranged for approximately $4 million in long-term financing from an insurance company.

▶Another entry in the growing list of tungsten rocket nozzle fabricators is the Rocket Engine Section of General Electric's Flight Propulsion Division. GE process uses wire-fed arc gun to spray tungsten on an intermediate material backed by graphite. Unlike high temperature plasma processes, GE says its process can be used to coat tungsten on any material that can withstand 375F. Company already has sold several tungsten nozzles which have been successfully test fired.

Barden Precision 206H5DB bearings as used in a computer storage drum

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Washington Roundup

Nuclear Plane Decision

Defense Department and Atomic Energy Commission have assured the Joint Congressional Committee on Atomic Energy that a firm program for construction of a subsonic nuclear aircraft prototype will soon be submitted to the President and to the committee, probably within a few weeks.

The assurances were made late last week during a meeting of key congressional and Pentagon officials. The session was called by members of the Joint Congressional Atomic Energy Committee in view of conflicting statements as to whether the late Donald A. Quarles, Deputy Secretary of Defense, had agreed to submit to the White House a program to accelerate the nuclear aircraft propulsion program and move forward with construction of two subsonic prototypes. Those attending the meeting were: Sen. Clinton Anderson (D.-N. M.), chairman of the Atomic Energy Committee; Rep. Melvin Price (D.-Ill.), chairman of the Subcommittee on Research and Development; Rep. James Van Zandt (R.-Pa.), ranking Republican on the committee; John A. McCone, chairman of the Atomic Energy Commission; Dr. Hebert York, Defense Department's director of research and engineering, and Hebert B. Loper, assistant to the Secretary of Defense for atomic energy.

Financial Storm Clouds

Watch for signs of another financial crisis in the Pentagon similar to conditions during the summer of 1957 when gross under-financing of major weapons development and procurement programs forced severe financial strictures on the aviation industry and its related technologies. Current indications are that the Pentagon will find itself close to $500 million short of the funds needed to finance programs scheduled for Fiscal 1960, with the real pinch coming in Fiscal 1961 when the gap between programs and financing may widen to as much as $2 billion.

Failure of top Pentagon officials to cut off current programs that are going down the military obsolescence curve and to make basic decisions between competing weapon systems is a major cause of the financial squeeze on new development programs. With an election year in 1960 when the Fiscal 1961 defense budget will reach the decisive point and the attention of both executive and legislative branches of the government, it can easily be diverted from the impending Pentagon crisis into a round of political battles.

ARDC Streamlining

Groundwork is being laid for a major streamlining of the Air Research and Development Command by its new commander Lt. Gen. Bernard A. Schreiver. Major goals will be to consolidate and realign field centers and to reduce the headquarters staff at Andrews Field near Washington. Gen. Schreiver has been a strong supporter of the Stever report (AW July 14, 1958, p. 29) and his streamlining moves can be expected to generally follow its major recommendations. Among the likely changes are:

- **Combine Cambridge and Rome** Development Centers into a single avionics development group.
- **Combine the Special Weapons Center** at Kirtland AFB and the Holloman Air Development Center into a single unit, with Holloman operating as a detachment of SWC and playing a diminishing role in the ARDC program.
- **Concentrate major propulsion** research at Edwards AFB, Calif., with existing facilities at Wright Air Development Center and Arnold Engineering Development Center directed from Edwards.
- **Emergence of the Ballistic** Missile Division at Inglewood, Calif., as the major missile development center with the Atlantic Missile Test Range and Patrick AFB operating as its test division.

R&D Personnel Shifts

Meanwhile, as a preliminary to any organizational changes, major personnel changes already have been made at ARDC. Maj. Gen. James Ferguson comes from the Pentagon as USAF director of requirements to become vice commander of ARDC on July 20, succeeding Maj. Gen. John Sessums, who is retiring. Maj. Gen. William M. Canterbury, now commander of the Special Weapons Center, will become deputy commander of ARDC for research, succeeding Maj. Gen. Leighton I. Davis, who goes to the Pentagon as assistant deputy chief of staff for development. Gen. Davis replaces Maj. Gen. Ralph Swafford, who becomes vice commander of the Air University. Other R&D personnel changes are:

Maj. Gen. Victor Haugen, now commander of the Directorate of Systems Management at WADC, will go to the Pentagon as director of development planning for the USAF deputy chief of staff for development, replacing Maj. Gen. Leland S. Stranathan, who becomes chief of the Caribbean Air Command.

Haugen also will inherit a small portion of the directorate of requirements which was formerly under the office of the Deputy Chief for Development. The requirements directorate itself, along with most of its personnel, was recently reassigned to the office of the Deputy Chief of Staff for Operations. It will be headed by Maj. Gen. Bruce K. Holoway who is being reassigned from the Tactical Air Command.

Maj. Gen. Charles McCorkle, former chief of guided missiles at USAF headquarters, will move to Kirtland as ARDC Special Weapons Center commander.

Space Unity

Unification of a sort has come to at least one part of the nation's space program. In the future, all satellites and space probes launched for the National Aeronautics and Space Administration will bear the label "United States" if they carry any label at all—regardless of what agency handles the launching. Some Mercury capsule models already bear this designation. Lunar probes launched last year were proposed by the services, funded by Advanced Research Projects Agency, transferred later to NASA, and launched by the services. Those fired by USAF carried only service labels. First Army-launched lunar probe was marked only "NASA." Then Pioneer IV carried the initials of both Army and NASA.

Standardizing the designation is one more attempt to demonstrate that the U.S. program is a unified, national effort.

—Washington staff

New Space Tempo May Increase Support

Series of satellites contemplated to circle earth in polar orbit to provide continuous surveillance.

Washington—Increased tempo of space technology, both in the U.S. and Russia, is gaining strong fiscal support for Air Force's WS-117L advanced reconnaissance system, which has been largely financed thus far on a hand-to-mouth basis.

Ultimate application of the WS-117L system, now being developed by Lockheed Aircraft's Missiles and Space Division under jurisdiction of the Advanced Research Projects Agency through USAF's Ballistic Missile Division, contemplates a series of satellites—perhaps as many as a dozen. Each of these will circle the earth in a north-south orbit in a 90-min. period for continuous, effective surveillance.

Known by a variety of project code labels, including Big Brother, Pied Piper, Sentry and, most recently, Midas, this reconnaissance satellite, may evolve into one of the most important U.S. systems insofar as the data acquisition potential in the immediate space spectrum is concerned.

The program has progressed in the past with tenuous funding on a month-to-month basis, although at times—particularly last September—there were strong indications that the program would be accelerated. Recently AVIATION WEEK has learned, the program funding dwindled to a one-day period, then was extended to cover another 10-day span.

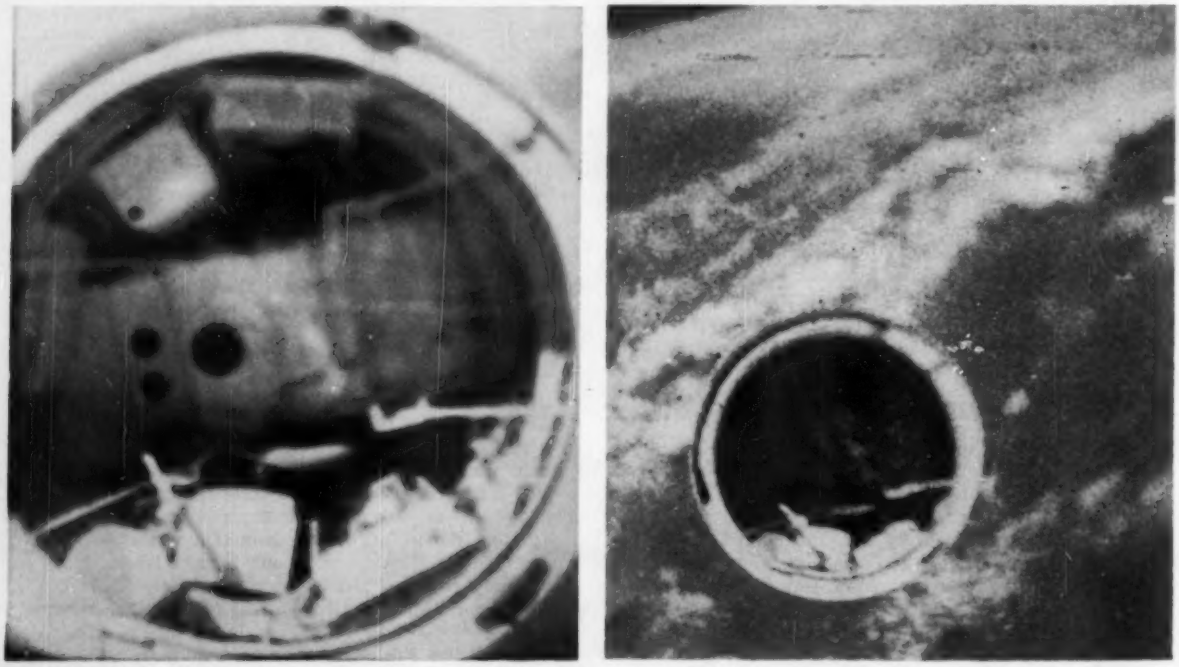
Now, the intention is, beginning with Fiscal 1960, to fund the WS-117L program on a yearly basis, and observers close to the picture believe that funding even on a quarterly basis would be a promising sign on future support. Definitive follow-on contract is expected to be inaugurated this month or early in June.

Early Part

The early part of WS-117L project, formerly known as Sentry/Thor, was broken out of the over-all program by the Advanced Research Projects Agency and given the designation Project Discoverer which is now being carried out to obtain north-south polar orbiting satellite trajectories from Vandenberg AFB, Calif.

Remainder of the presently planned WS-117L advanced reconnaissance satellite program using the Convair-built Atlas as a booster includes:

- **Initial firing of the Atlas**-boosted WS-117L vehicle, known as Sentry/Atlas, probably will be in January, 1960. Under this timetable, the program will overlap that of Project Discoverer which has deviated from its original time schedule but is being accelerated to include two-a-month firings. Discoverer also is an ARPA/BMD project, with Lockheed's Missiles and Space Division as principal contractor. Data amassed in Discoverer orbitings will be funneled into Sentry/Atlas, which will be a natural follow-on to the Discoverer program.
- **By mid-1960,** WS-117L Sentry schedule may be accelerated so that firings will be conducted at the rate of about one a month.
- **First firings in this series** will be from the Air Force missile Test Center, Cape Canaveral, Fla., since complete launching facilities for the Atlas booster vehicle are not scheduled to be ready at Vandenberg AFB in time to accommodate the initial phase of the program.
- **Reconnaissance capability** by optics will be attempted initially to reveal the



SEPARATION of an Air Force Thor intermediate range ballistic missile nose cone from its booster 115 mi. downrange from Cape Canaveral, Fla., was photographed by a 16 mm. ACR Electronics Corp. camera installed in a re-entry vehicle data capsule designed by General Electric. Sequence indicates reconnaissance potential of WS-117L. Field of vision downward was 51 deg. Sequence, made at an altitude of 90 mi., shows (from left) forward end of the booster a few seconds after separation; the booster as it began to drop away while

For WS-117

view from orbiting vehicle. A record will be made by camera, and the film package will be ejected at a predetermined point in the orbit for recovery with parachute or an equivalent system.

• **Advanced plan contemplates** developing the exposed film in the satellite and reading out results electronically to a ground station. This sophisticated approach, although more complicated than the film recovery technique, is more in keeping with the desired returns from a satellite with true reconnaissance capability.

• **Infrared scanning development** for the WS-117L program will be known as Midas (AW Feb. 23, p. 34). Potentially, this satellite infrared sensing capability could be adapted for early warning of anti-ICBM emplacements in order to substantially extend the alert time for instituting tracking and interception. One limitation of the system is that for true effectiveness, the infrared sensor would be required to focus on the tail end of the ICBM where the heat of exhaust emerges.

• **Television camera scanning** is not now included in the Sentry scheme.

• **Previous plan for the nose** cone to embody a clamshell configuration which would open for viewing, once a firm projection, has now been changed. Inside of the open clamshell, petals were intended to be used as antennas, but a newer, more efficient arrangement has been devised which will obviate this antenna scheme and the necessity for the nose cone to open for viewing.

• **Second stage of the WS-117L** Sentry vehicle is scheduled to be the Bell Hustler rocket engine now being used as the second stage of the Project Discoverer vehicle, which uses a Douglas-built Thor as a booster. The Bell liquid-propellant engine, an advanced version of the powerplant originally designed to supplement the engines for Convair's B-58 Hustler bomber, will develop in excess of 15,200 lb. vacuum thrust, using unsymmetrical dimethyl hydrazine and inhibited red fuming nitric acid as the propellant combination.

• **Instrumented nose cone** coupled to the Bell second-stage engine will orbit as an integral unit comprising the satellite. This is the same scheme used for the Discoverer satellite polar orbit.

• **Total weight of Atlas payload**—second stage plus instrumented forward section—will weigh approximately 8,000 lb., indicating a substantial increase in payload capability over that of the Thor-boosted Discoverer satellite vehicle.

• **Nominal orbiting altitude** will be 300-400 mi. Circular or near-circular orbit will be a difficult goal.

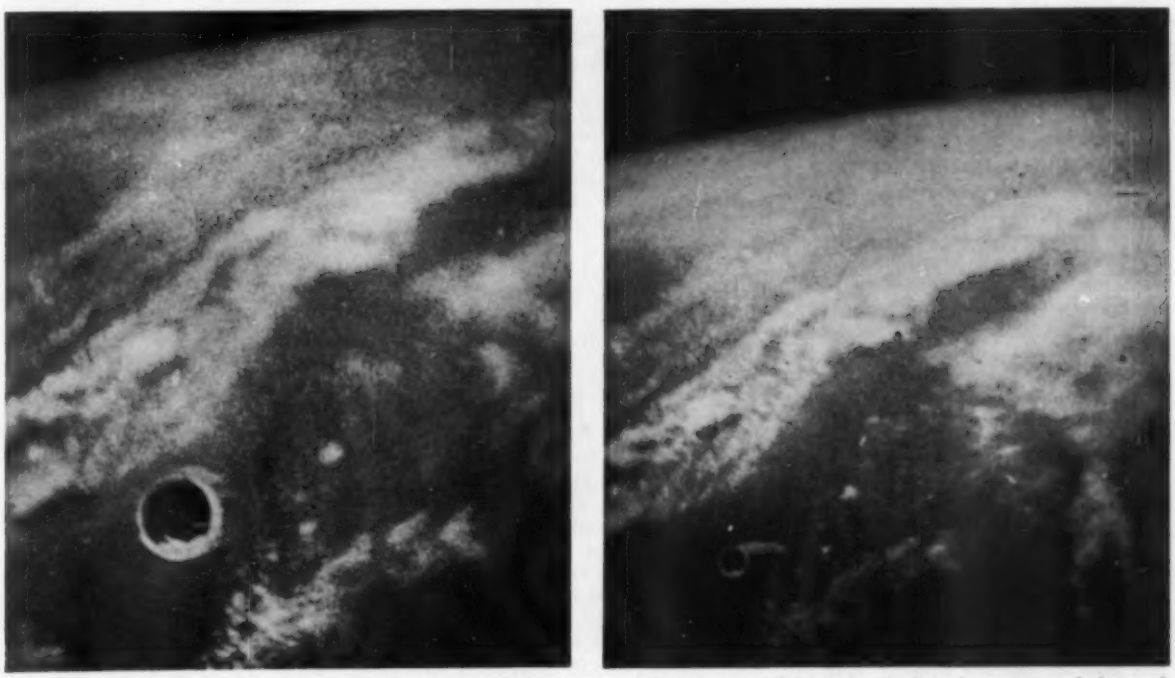
• **Responsibility for building** the integral nose cone-Bell rocket engine second stage will be Lockheed's. The firm also will have responsibility for checkout and static test of the engine second-stage vehicle at Santa Cruz, Calif.

A number of subcontractors will be associated with Lockheed in the WS-117L program. Philco Corp. will supply space-ground communications equipment.

Eastman Kodak Co. and Itek Corp., Palo Alto, are concerned with reconnaissance aspects. Itek, in addition to having photo-optical capabilities, also works in the field of aero-space reconnaissance and in information retrieval.

Under contract from Air Research and Development Command's Rome, N. Y., Air Development Center, Thompson Ramo Wooldridge is working on a plan for handling over-all intelligence from the WS-117L satellite through its Reconnaissance Data Processing Project Office. Subcontracted to Thompson Ramo Wooldridge is Systems Laboratory Corp., which is concerned with analysis in the field of photogrammetry to resolve data received from the satellite. The program includes use of ground equipment which classifies, codifies and chops pictures for storage in convenient sizes. This equipment probably won't be available until the WS-117L program is well under way.

In connection with these photogrammetric calculations, orbital studies and attitude control procedures are involved because these are both related to the photogrammetric analysis.



the re-entry vehicle continued on a programed ascent to a 300 mi. apogee; the booster falling farther back and curvature of the earth becoming quite evident, and (far right) the booster falling slightly to the right. Land mass is the Florida area and a weather front covering hundreds of miles can be seen. Data capsule, which weighed 65 lb., was automatically ejected from the re-entry vehicle and parachuted down; recovery was made by an Atlantic Missile Range vessel about 1,400 mi. downrange and 39 min. after firing.

Lockheed Plans To Acquire Stavid To Strengthen Avionics Position

Lockheed Aircraft Corp. has completed arrangements for the first of several acquisitions planned to increase its avionics potential and place it in a better position to compete in the future for the very large weapon systems contracts it foresees. Word on acquisition of a second avionics company is expected late this week.

Under an agreement reached 10 days ago by the boards of directors, Lockheed will acquire Stavid Engineering, Inc., Plainfield, N. J., as a wholly-owned subsidiary. After approval of the merger by Stavid's stockholders at a special meeting next month, the avionics company will become a separate division of Lockheed.

In preparation for its rapid expansion into the avionics and associated fields, Lockheed has investigated some 96 companies throughout the country. A study team on acquisitions was set up last year by Lockheed's chairman and chief executive officer, Robert E. Gross, under the direction of now-retired Charles Barker, former senior vice president and the company's chief financial adviser.

These investigations have included each company's present position in the industry, growth potential, technical competency, earnings, and caliber of officers and staff. Several of the investigations have been responsible for triggering stock market rumors of impending mergers over the past several months—including Hoffman Electronics, Sylvania, Lear, and Philco Corp.

Stavid is the second company that Lockheed has acquired. Recently it acquired Puget Sound Bridge and Dredging Co. which has facilities that may be used in conjunction with the Polaris program. Company also has had experience in setting up military bases overseas and this experience may be employed for missile launching sites.

Under the terms of the agreement between Lockheed and Stavid, each share of Stavid common stock will be exchanged for 2.5 shares of Lockheed common stock. At the present time, Stavid has approximately 213,000 common shares outstanding. Late last week Lockheed's common stock was selling for about $33 per share, so the gross value of the transaction will be in excess of $17 million.

Although the acquisition must wait for final approval of Stavid stockholders at next month's special meeting, the number of shares of captive stock—the minority shares held by Stavid's management and by Laurance S. Rockefeller—assures for practical purposes the acceptance of Lockheed's offer.

Last year Stavid had gross sales totaling $11.2 million, from which it earned $294,000. Slightly more than 90% of the company's business is military although the company has been studying possible methods of diversification. Lockheed's last year's sales totaled $962.6 million, of which slightly less than one third was for missiles and space projects. Lockheed has a present backlog in excess of $1 billion.

In discussing with AVIATION WEEK the reasons behind the merger, Stavid's president, David F. Sanders, said the growth potential of Lockheed was one major consideration. The second major reason, he said, was that Stavid believed the next two to three years will show a definite shift in military procurement to fewer and bigger weapon systems.

This does not mean, he said, the end of the team concept which Stavid has in the past strongly supported. It does mean, however, that the larger contractors will receive larger shares of the total business. Stavid now has a staff of about 1,000. Sanders believes that the merger means that the growth of Stavid over the next few years will be limited only by the number of qualified people the company can hire.

No changes are planned in Stavid's management or policies as a result of the merger. The company's executive vice president is F. J. Reynolds; J. H. Hunt is vice president for manufacturing, and W. A. Schneider is vice-president for research and development.

Negotiations between two other companies have been terminated recently. Exploratory conversations that were being held between the Martin Co. and General Precision Equipment Corp. have been dropped and there are no active negotiations under way between the two companies, James Murray, General Precision board chairman told AVIATION WEEK.

Titan Control Sequence

Washington—Air Force-Martin Titan intercontinental missile uses four vernier nozzles in second stage for velocity and trajectory refinements. First stage uses gimbaling of two engines for pitch and yaw control, vent from the gas generator for roll control.

Separation sequence begins when the automatic programer shuts down the first stage engines. Programer then blows four explosive bolts, lights solid "pusher" rocket engines that nudge the second stage forward, and starts the gas generator system in the second stage, which vents through four vernier nozzles at the bottom circumference of the second stage. With verniers running, stage two engine is then ignited.

After the second stage engine shuts down, funnel-shaped verniers continue to operate, making final course and speed corrections. At the same instant that the verniers stop, the second stage is backed away from the warhead by venting the gas generator tank forward through a port located at a point below the separation point of stage and warhead. Warhead then continues on its course. It, too, uses inert gas expanded through four nozzles for attitude control.

Deputy Secretary Post To Be Filled by Gates

Washington—Outgoing Navy Secretary Thomas S. Gates, Jr., who had been scheduled to retire on June 30, was named Deputy Secretary of Defense last week in the wake of the death of Donald A. Quarles (AW May 18, p. 39).

Quarles' death also brought an announcement from Defense Secretary Neil McElroy that he has "indefinitely" suspended his plans to resign within the near future and return to Proctor and Gamble.

In another move, McElroy recalled Adm. Arthur W. Radford, former chairman of the Joint Chiefs of Staff, from retirement to act as the Defense Secretary's technical adviser in a civilian capacity during the absence of Gen. Nathan F. Twining, Radford's successor as chairman of the Joint Chiefs, who just recently underwent a cancer operation.

Gates, who had planned to return to the Philadelphia investment firm of Drexel & Co., will now be in line to succeed McElroy upon the latter's retirement.

The Defense Secretary still hopes to eventually retire, possibly by the end of the year.

Gates' nomination received speedy Senate confirmation last week.

Meanwhile, a special presidential directive has empowered Gates to act as Defense Secretary while McElroy attends the foreign ministers' conference in Geneva.

Before leaving for the conference, McElroy said he had promised President Eisenhower to stay on the job until the Fiscal 1961 defense budget, which will be submitted to Congress in January, is "wrapped up," and that it would take some time for Gates to break into his new job. He also said the foreign ministers' meeting and the developments that might arise from a summit conference had influenced his decision to delay his resignation.

Aeroflot Plans Decca Evaluation; May Also Buy Long-Range Unit

Moscow—Aeroflot, the Soviet Union's state owned airline, will install a British-developed Decca navigation system here for a six-month evaluation and plans to extend Decca coverage throughout the USSR if the system proves "as good as we think it is," according to Aeroflot deputy chief Col. I. Bashkirov. Disclosure of the plan was made here during recent British-Russian trade talks.

British officials say the Russians also may use the Dectra long-range version of Decca which is now undergoing evaluation in the North Atlantic. The Russians are not members of the International Civil Aviation Organization and are not bound by its final decision on the subject of an international standard navigation aid.

British sources say the Soviets investigated the U. S. VOR/DMET navigation system as well as the rival Decca system before selecting the latter for evaluation. Col. Bashkirov was given flight demonstrations of the Decca system, but U. S. Federal Aviation Agency officials say the USSR has never requested either technical information or a demonstration of VOR/DMET.

One factor of the USSR decision may have been the fact that the sale of U.S. VOR/DMET equipment to the Russians is banned. Whether the State Department would rescind the ban if requested by the Soviets is a matter of speculation. British sources believe that the Russians may ask for license to manufacture Decca in Russia.

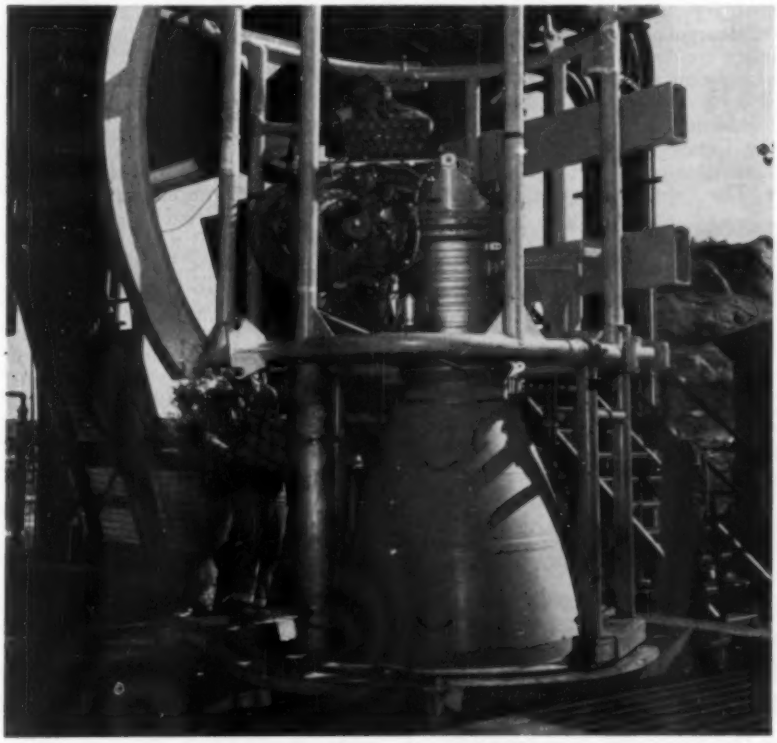
Initial trials will be conducted with Decca installations in one or two Tu-104 jet transports. If the system is adopted, it will be installed first in Aeroflot's Il-18 fleet, according to Col. Bashkirov.

Because the DMET portion of the U. S. system is a key element in the military Tacan navigation system, one U. S. military spokesman told AVIATION WEEK he is "just as happy" that the Soviets will not get direct first-hand knowledge of the system's details which will make it a little more difficult for the Russians to devise jamming techniques. He also speculated that a Soviet Decca installation could be quickly modified to act as a jammer for existing Western European networks in the event of worsening international relations.

B-70 Data System

Washington—Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, has been awarded a contract to develop and manufacture the Central Air Data System for the North American Aviation's Mach 3 B-70 intercontinental bomber.

The contract was awarded to AiResearch by North American, weapon system contractor to the Air Force on the B-70 project. The Garrett Corp. division received a contract in November to develop a similar system for North American's F-108 Mach 3 long-range interceptor.



Saturn Booster Cluster

First rocket engine for use in a 1.5 million lb. thrust Saturn booster cluster has been delivered to the Army Ballistic Missile Agency by Rocketdyne. Eight of these engines will be clustered for the Saturn which is expected to fly for the first time in 1960. Saturn design specifications call for four of the engines to be gimbaled to provide control. Each of the eight will be completely separate units so that they can operate independently. This would allow Saturn vehicles to complete a mission with one engine out. Such design would cut the payload but raise the over-all reliability of the vehicle.

T. V. Jones Named Northrop President

Beverly Hills, Calif.—Thomas V. Jones was named president of Northrop Corp. last week, succeeding the late Whitley C. Collins. At the same time, James Allen, vice president and assistant to the president, was named corporate vice president and assistant to the board chairman.

Jones, who stepped up from the post of senior vice president, joined Northrop in 1953 as assistant to the chief engineer. He was named corporate vice president for development planning in 1957.

The following year he was promoted to senior vice president and, early this year, was named a member of the board of directors.

The newly-elected president also serves as consultant to the aeronautic and space vehicles panel of the Air Force Scientific Advisory Board and, until recently, was consultant to the Assistant Secretary of Defense for Research and Engineering.

First Ballistic Missile Submarine to Be Launched

First fleet ballistic missile submarine, the George Washington, will be launched June 9 at General Dynamics Corp.'s Electric Boat Division at Groton, Conn. Submarine will be equipped with Polaris underwater missile.

Bill to Extend Renegotiation Act Protested by Republican Group

Washington—Nine Republican members of the 25-member House Ways and Means Committee are protesting the recommendation for a four-year extension of the Renegotiation Law voted without major change by the committee majority (AW May 18, p. 29).

The Republicans have complained that the committee acted hastily and failed "to deal adequately with serious criticisms of" renegotiation. Three days of public hearings and one week of executive sessions were held prior to the committee vote.

The outlook, however, is that the majority bill, giving contractors new rights in contesting renegotiation cases in the courts but making only minor changes in the administration by the Renegotiation Board, will be approved by the House intact.

Last August, in extending renegotiation for six months to June 30, 1959, the committee formally promised "a broad review of the entire subject" early this year. The Republican minority has now complained that "no such review has been undertaken. . . ." The Republican members urged a short-term extension and the appointment of a subcommittee to undertake a comprehensive study.

The Republicans also pointed out that the House Armed Services Investigating Subcommittee, following a study of the airframe industry in 1956, reported that profits were not excessive and recommended a study of "the regulations and conduct" of the Renegotiation Board (AW July 23, 1956, p. 28). A few weeks ago, Rep. Carl Vinson (D.-Ga.), chairman of the full Armed Services Committee, charged aircraft manufacturers with high profits and advocated that the Renegotiation Law "as is" be made permanent.

The Republicans, however, maintained that these four "serious criticisms" of renegotiation, made in testimony by William M. Allen, president of Boeing Airplane Co., and other industry witnesses, should be solved before any long-term extension is approved:

- **"The term 'excessive profits'** requires further statutory definition in the light of the Renegotiation Board's alleged practice of seeking to recapture normal profits or contractually agreed upon incentive profits;
- **"Renegotiation proceedings** before the board are devoid of any character of a negotiation and, instead, bear an aura of a tribunal process where the contractor is tried without knowledge of the factors the Board secretly weighs against his position.
- **"The economic impact** of renegotiation discourages competition by limiting the number of firms willing to undertake defense contracts, and that economic impact is causing our defense-related industries to rely increasingly on government-financed capital investment instead of relying on retained earnings and new private capital investment.
- **"Continuation of the renegotiation** authority acts as a positive deterrent to the further development and use of effective defense procurement procedures that would give increased emphasis to cost reductions while at the same time safeguarding against excessive profits."

Because of the failure to provide solutions to these "short-comings," the Republicans said they were "particularly concerned" with the proposed extension "for an unprecedented four-year period." This, they said, "will effectively remove the subject . . . from the scrutiny of the Congress for the duration" and "will further delay the Defense Department in practicing procurement policies that obviate the renegotiation process."

Two of the nine Republicans—Rep. Thomas Curtis (Mo.) and Rep. Bruce Alger (Tex.)—recommended an end to renegotiation in supplemental opinions.

Rep. Curtis said renegotiation "is a procurement crutch—needed perhaps in the periods of crash procurement programs during war. In times of peace, this crutch prevents the development of the sound procurement practices upon which defense procurement should stand if it is to be healthy." He added that Defense Department's support for continuation of renegotiation "is a matter of a warped idea of public relations. As long as there is an act which says it is to prevent 'excess profits,' the Defense Department, badgered as it is by unfavorable publicity about its procurement practices, feels that it has a protection. It points to this act to reassure the public that there are not excess profits in military contracts."

Rep. Alger declared that renegotiation "is self-defeating and ultimately rewards inefficiency instead of strengthening the incentive for efficiency and cost reduction." He said that contract adjustments should be made by the original Defense Department contracting officers "who are best informed with respect to the factors and considerations involved" and that a congressional committee should be established "to maintain continuing surveillance of defense contracting."

The seven other protesting Republicans were Rep. Richard Simpson (Pa.); Rep. Noah Mason (Ill.); Rep. Howard Baker (Tenn.); Rep. Victor Knox (Mich.); Rep. James Utt (Calif.); Rep. Jackson Betts (Ohio); and Rep. Albert Bosch (N. Y.).

Ablative Nose Cone Shows Re-Entry Effect

RVX-1 materials research re-entry vehicle—the Thor-Able ablative nose cone recovered from the South Atlantic last April 8 (AW May 18, p. 39) after a 5,000 naut. mi. flight—shows the effect of its 15,000 mph. re-entry during which the forward tip reached a temperature in excess of 12,000F. Total ablation of the approximately 700 lb. vehicle was a very small part of its weight. Note that much of the material that ablated from the nose flowed back and was deposited on the cylindrical body although aerodynamic stability was not affected. Smooth forward section of the nose has been cleaned and filled with plastic to conceal any characteristic of the ablative material that might reveal its identity. Lt. Gen. Bernard A. Schriever, commander of ARDC which recovered the nose cone, is at right. Kendrick R. Wilson, president of Avco Corp. which developed the nose cone, is at left.

Senate Unit Says Nike 'Virtually Obsolete'

Washington—Senate Armed Services Committee has issued a report declaring that the Army Nike Ajax, Nike Hercules system point air defense system "is virtually obsolete."

In the latest development in the long controversy surrounding the Nike versus the Air Force Boeing Bomarc area defense systems which is now apparently nearing a showdown, the report added that "the further expenditure of funds to expand the (Nike) system, except in overseas areas where it might have a tactical value, is unwarranted."

The committee said:

"The Nike system has evolved through several stages—Nike Ajax, Nike Hercules, and later, an improved Nike Hercules. These modifications and conversions have entailed large expenditures while achieving relatively modest extensions in the range at which an incoming aircraft could be detected and destroyed. This range capability could be seriously inadequate, particularly against 'standoff' bombers equipped with air-to-surface missiles.

"Although the military construction costs of converting Nike Ajax sites is relatively minor, the cost in missiles, warheads and personnel is substantial. The committee is disturbed by the dangers attending the storage of atomic warheads for these missiles in populated areas. Another danger is that which would result from the detonation of these atomic warheads at short ranges over the defended populated areas.

"It is the committee's view that intercontinental ballistic missiles are becoming the primary threat to bases of the Strategic Air Command and that the required missile defense against aircraft should be provided by area type weapons that afford multi-purpose protection of cities, strategic bases, and other vital facilities."

To back up its views, the committee has slashed funds for Nike Hercules facilities in the $1.2 billion military construction authorization and directed Defense Secretary Neil McElroy to present a "master plan" for air defense before the adjournment of Congress.

The action was influenced by earlier testimony before the Senate Appropriations Committee in which Secretary of Defense McElroy said that "it would not bother me if you held our feet to the fire and forced us" into a decision between Nike Hercules and Bomarc in the air defense program (AW May 11, p. 26). Sen. John Stennis (D.-Miss.), chairman of the Armed Services Subcommittee on Construction, at the time replied to McElroy: "I appreciate your attitude tremendously, because I frankly think that is what has to be done."

McElroy had testified that the aim of the air defense program should be to achieve maximum "reach out" with interceptors and Bomarc missiles "and only a relatively small number of additional high priority target areas will be considered as further Nike sites, I believe." Stennis commented: "I can understand your leanings toward Bomarc. Apparently its future being so much more extensive, I cannot understand why you keep recommending the installations and support installations for Nike."

The Armed Services report recalled that "for several years the committee has emphasized the importance of decisive action by the Department of Defense to eliminate wasteful overlapping in weapon systems. This is particularly true in the area of anti-aircraft missiles which have been the subject of extensive discussion and deliberation. In an attempt to force a decision in this regard, the committee last year reduced the construction authorization for anti-aircraft missiles by 20% and made the combined remainder available for utilization in the systems selected by the Secretary of Defense. The committee was desirous that an entire reappraisal be made of the air-defense concept solely in terms of effectiveness and without preference to individual systems or military departments to assure the most defense for the dollar invested (AW Aug. 11, p. 21).

"The clear cut decision has not been made."

Meanwhile, McElroy, in a letter to Sen. Dennis Chavez (D.-N. M.), chairman of the Appropriations Subcommittee on the Armed Services, modified his previous testimony strongly favoring Bomarc over Nike Hercules. McElroy wrote:

"The thing which I said would not be disturbing to us would be for the Congress to press us to present to it a master plan covering the numbers of Bomarc and Nike sites we believe are required, together with their locations.

"Nothing in this suggestion was meant to indicate that there would not be a place for both the Nike Hercules and the Bomarc . . . our concept of defense in depth leaves a place for both types of missile systems."

Defense Idea Requirements Listed

Washington—A trailing aerodynamic decelerator capable of slowing hypersonic vehicles in low air densities while operating to 1,800F is one of 28 new ideas needed by the armed forces, according to the National Inventors Council of the U. S. Department of Commerce. The aerodynamic decelerator, the council said, should be capable of changing drag area by a factor of 100:1, if possible, and should be capable of being stored in a small volume.

Other ideas sought include:

- **Angle of attack sensor** capable of hypersonic speed and high temperatures in fringe of earth's atmosphere.
- **Altimeters capable** of measuring pressure altitude at 500,000 ft. or higher.
- **Electronically scannable** antenna which does not employ frequency shift to achieve scanning.
- **High power, low-loss** ferrites for use as phase shifters.
- **Broadband Maser amplifier** for use in the microwave region.
- **Reusable photo storage medium,** providing fine grain resolution and sensitivity comparable to present fast films, which can be processed as easily as magnetic tape and provides visible image on a flexible support.
- **Data transmitting devices,** which are accurate and repeatable to within 30 sec. of arc.

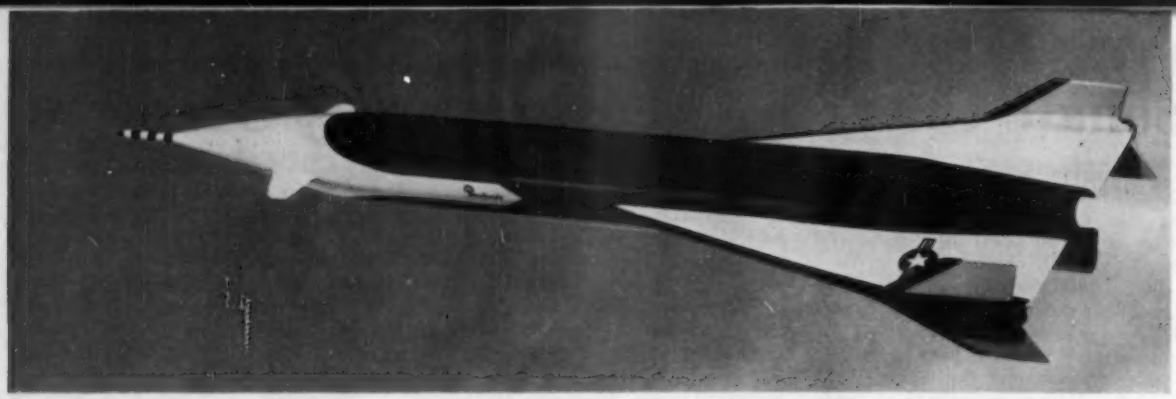
At least one desired invention listed appears to have been accomplished recently. The new Westinghouse Electric process for fabricating dendritic crystals of germanium and silicon in long, thin ribbons (AW April 27, p. 54) appears to meet the council's request for "germanium and silicon single crystals grown in ribbons or rods . . . to sizes suitable for direct fabrication into diodes, transistors, solar cells, etc."

The 28 new ideas, plus five revised problems, are listed in "Supplement to Technical Problems Affecting National Defense," National Inventors Council, Department of Commerce, Washington 25, D. C.

Propellant Contract

Washington — National Aeronautics and Space Administration last week announced the award of a $175,000 contract to Callery Chemical Co. for evaluation of a non-cryogenic rocket propellant, possibly boron, which could have both liquid and solid applications.

Under the contract, Callery is to determine the feasibility of the propellant and report its findings to NASA in approximately eight months. Study will be conducted at Callery's laboratories in Callery, Pa. A major subcontractor is Reaction Motors, Inc., division of Thiokol Chemical Co.



BEECH XKD2B-1 air-launched Mach 2 missile target will be powered by a dual thrust chamber liquid propellant rocket engine.

Services Seek Versatile Missile Targets

By Michael Yaffee

Washington—Joint Navy-Air Force award to Beech Aircraft Corp. for the development of a new high-speed missile target, the XKD2B-1 (AW May 18, p. 39), leaves the Army's high-low vehicle as the one major target drone competition still undecided for the current fiscal year, now rapidly drawing to a close.

The Army high-low competition for research and development of a new supersonic missile target (in many ways similar to the joint Air Force-Navy vehicle) has reportedly run into a financial roadblock.

If the Army can find the funds, it wants to revive the competition immediately and not hold it over for next year's budget. The Army has already carried out an extensive evaluation, narrowing the field of competitors to a few finalists, and would like to announce the award of the research and development contract, as it had planned, before July 1.

Making a determined effort to set up its own missile target programs (rather than continue having to buy vehicles developed under the aegis of the Air Force or Navy), the Army already has reportedly dropped one drone competition for the current year.

This program, which may be resurrected next year, was for the development of a medium performance (400-500 kt.) cruise type drone believed to be in the same class as the advanced Ryan Firebee, the Q-2C. Among other things, the Army reportedly was dissatisfied with the submitted proposals which, for the most part, were based on modifications of existing vehicles.

Air Force competition for the development of a high performance target system for its North American F-108 Mach 3 fighter is still in the planning stage. North American Aviation (Columbus), after sounding out drone manufacturers on the idea, has recommended the development of a new target system for the F-108 to the Air Force. Although the new XKD2B-1 which is expected to be operational in 1962 is considered in some quarters as a potential target candidate for the F-108, Beech says it is not. In any case, the matter of an F-108 target rests at Air Force Headquarters and has not yet filtered down to ARDC which would conduct any actual competition.

Even somewhat further in the future is the military's anticipated requirement for a fairly advanced missile target

AERONCA P-106, proposed as a low-cost, ground-launched supersonic target for Army missiles, has a ramrocket powerplant.

status, the program is turned over to the Production Division of BuAer's Development and Procurement Divisions follows the development of all has been transferred to the new office of Deputy Chief of Naval Operations

capable of operating at Mach 5 to altitudes of 100,000 ft. This is considered a third or fourth generation target system; and although not yet an officially established project, it appears to be a definite prospect for some future competition.

There will also, of course, be other missile target competitions set up as the requirements arise. Whenever military intelligence reports the existence of a new enemy aircraft or missile, the responsible U.S. service or services will put out a call for the development of a new target missile that will simulate the "threat" craft on instruments in regard to speed, altitude and appearance.

Guided Missile Target

The Beech XKD2B-1 is designed to meet the Air Force and Navy need for an air launched, low cost, high speed target for training pilots who will be firing radar and infrared guided missiles. Later, the Navy plans to use the vehicle as a target for ship-launched air defense missiles. The target is considered expendable and is expected to cost under $20,000 per unit in production.

Unlike most existing drones, the XKD2B-1 will have, in accordance with Air Force-Navy requirements, a self-contained guidance system. And in at least one case, this has now become the basis for differentiating between drones controlled by ground command and the new target missiles such as the XKD2B-1 and the Army's still pending high-low target. As a term, some engineers feel, drone will best be reserved in the future for surveillance and reconnaissance type vehicles.

Its guidance system allows the XKD-2B-1 to seek its preset altitudes and speeds for pilot training problems. The vehicle will be capable of level flight at any predetermined altitude from 5,000 to 70,000 ft. Flight duration can be five minutes at Mach 2 or eight minutes at Mach 1.5. Actual duration will depend upon altitude at which the vehicle is launched.

Launching Altitude

At present, plans call for launching the XKD2B-1 at any altitude between 5,000 and 35,000 ft. Once it is launched, the vehicle will be boosted to its present cruise altitude, say 70,000 ft., where it will fly as long as its remaining fuel (that which was not consumed during the boost phase) lasts.

One of the more unusual features of the XKD2B-1 is its powerplant. This is a dual thrust chamber, liquid propellant rocket engine. Both thrust chambers fire during the boost phase with one of them cutting out once the vehicle reaches cruise altitude.

Designed to simulate some unspecified enemy "threat" aircraft, the XKD-2B-1, says Beech, will have a simple hit-or-miss scoring system, a self-destruct system, and will be capable of operating in all climatic environments.

The Army high-low target competition is aimed at the development of a low cost, expendable vehicle with a somewhat greater altitude and speed capability than the joint Navy-Air Force project. The new missile target will be expected to go from transonic speeds at sea level (Mach 0.9-1.2 at 10,000 ft.) to possibly Mach 3 at 80,000 ft. Although officially not associated with any specific weapon systems, the missile target is believed to be destined for use principally with the Hawk and Nike Hercules.

The Army missile target will be modified to perform either a high-altitude mission or a low-altitude mission by changing configuration and propulsion slightly to optimize the target for a specified flight regime. Basically, however, both the high and low altitude versions will be one and the same vehicle.

Self-Contained Guidance

Like the XKD2B-1, the Army vehicle will have self-contained guidance. Unlike the Beech vehicle, the Army missile target will be ground-launched and, as a result, will weigh somewhat more.

Many of the companies that entered the Navy-Air Force competition also entered the Army high-low competition. Among these companies were Beech, Aeronca, Republic and Bendix. Beech, winner of the Air Force-Navy competition, did not make the finals of the Army high-low competition. Bendix Systems Division and Republic's Guided Missile Division entered the high-low competition together, with Bendix the potential prime, and are believed to have made the finals.

Aeronca, which entered the competitions as prime on a team with Emerson Electric and Experiment, Inc., proposed the P-106 for the Army program and the P-107 for the Navy-Air Force competition. Both vehicles are very similar and feature a somewhat unusual ramrocket powerplant developed by Experiment, Inc.

Both the P-106 and P-107, says Aeronca, would cost less than $10,000 per unit in production. The ground launched P-106 would use a solid propellant rocket booster to push it to altitude. Due to the difference in the length of the nose cones, the P-106 is about 3-ft. longer than the P-107.

Of the various special features of both vehicles such as a "unique scoring system which operates in the ultraviolet region," the Aeronca team is particularly proud of the ramrocket propulsion unit. No one other factor, says Aeronca, probably has as much influence on target vehicle size and cost as propulsion. And after a long evaluation of different propulsion systems, the company decided on the ramrocket as the ideal choice for a low cost, transonic-supersonic target.

Ramrocket Advantages

Among other things, the ramrocket is capable of self acceleration and therefore requires only a small booster to reach altitude in comparison with a straight ramjet. Compared with a straight rocket, it offers somewhat lower fuel consumption and, as a result, somewhat longer flight time. Faced with essentially the same problem, other companies feel the pyrophoric ramjet engine is a better answer (see p. 85). And still other companies feel that the powerplant is the least of the problems faced in developing a low cost, transonic-supersonic missile target to operate at altitudes ranging from sea level to 70,000-80,000 ft.

The greatest problem, as far as Bendix Systems Division is concerned, was the development of an effective control system for a vehicle that is called upon to operate in the varying air densities in the widely ranging flight regimes specified for both of the new missile targets. To solve this problem, Bendix did away with all-movable control surfaces, turning instead to a reaction jet control system similar to that used on North American's X-15.

On the administrative side, the military drone or missile-target picture is complicated not only by nomenclature but also by the types of vehicles involved and the assignment of responsibility for development, production and procurement. In the Air Force, once a requirement is established for any kind of drone or target (including towed targets), the project is usually turned over to ARDC which will then follow the vehicle through from competition to production. Actual procurement of the vehicles falls to AMC.

Similar Goals

In the case of the current joint venture with the Navy, the Air Force discovered through liaison at a fairly early stage in the project that both services were striving toward essentially the same end. So ARDC went to the Department of Defense for approval to join BuAer on a 50-50 basis in the development of the vehicle. BuAer was made the executive agency and ARDC placed a liaison officer in the cognizant BuAer office to follow the development of the project.

Normally the Navy assigns the responsibility for the development of all its targets, drones, etc., to the Target and Special Aircraft Branch, Guided Missile Division, Research and Development Group, Bureau of Aeronautics. When the vehicle reaches production

THE MAGIC

status, the program is turned over to the Production Division of BuAer's Materiel and Services Group which carries out actual procurement under a production contract.

The Army, on the other hand, divides the responsibility for its drones and targets. Surveillance drones are assigned to the Signal Corps and targets to the Ordnance Corps. The recently established Army Combat Surveillance Agency of the chief Signal Corps officer, working through other Signal Corps groups such as the Research and Development and Procurement Divisions, follows the development of all surveillance drone projects right through actual procurement.

Target drone research and development is handled by the Research and Development Division of the Ordnance Corps. While various Army commands at places such as White Sands Proving Ground, N. M., are given funds to purchase target drones, actual procurement is, under normal conditions, carried out through the different Ordnance district offices.

Navy Drafts Final Merger Plans To Establish Bureau of Weapons

Washington—Navy is drafting final plans for the merger of the Bureau of Aeronautics and Bureau of Ordnance into a single, over-all Bureau of Naval Weapons and hopes to obtain the necessary enabling legislation before this summer's congressional recess.

Plans for the merger—which will create Navy's largest, and probably most powerful, bureau—were approved earlier this month by outgoing Navy Secretary Thomas S. Gates, Jr. Gates, who is stepping up to the post of Deputy Secretary of Defense, said in his order approving the merger that it "will have a profound influence on our future."

Details of the merger, and just how it should be carried out, are now under study by a group headed by Vice-Adm. E. W. Clexton, chief of the Office of Navy Materiel. The group began work on May 11 and has instructions to submit its final report at the earliest possible date.

However, because of the need for the study and enabling legislation from Congress, no definite timetable has been drafted for the merger.

Consolidation of the responsibilities and duties of the two bureaus was one of two major recommendations made by a seven-man committee headed by Under Secretary William B. Franke (AW Mar. 30, p. 40), who succeeds Gates as Navy Secretary.

The other—to establish a Deputy Chief of Naval Operations for Development with three-star rank to succeed the two-star Assistant Chief of Naval Operations for Research and Development—already has been approved (AW May 11, p. 30).

In approving the bureau merger, Secretary Gates also agreed to a number of other proposals recommended by the Franke committee in an effort to consolidate Navy's research and development effort and abolish overlaps in authority and missions, including a cutback in the operational scope of the Deputy Chief of Naval Operations for Air (Op-5).

A study group established by the Chief of Naval Operations is now implementing orders to restrict the duties of Op-5 to the fields of aviation plans, programs, requirements, training and safety—stripping it of the function of coordinator of the air reserve program and the present divisions of Guided Missiles, Flight Services (less the civil aviation liaison branch), Air Warfare and Naval Weather Service.

The Guided Missiles Division already has been transferred to the new office of Deputy Chief of Naval Operations for Development headed by Vice Adm. J. T. Hayward. The Air Warfare Division also will be transferred to this office.

The Weather Division will be shifted to the Deputy Chief of Naval Operations for Fleet Operations and Readiness; the air reserve program to the Deputy Chief for Personnel and Naval Reserve.

Over-all, the transfers and shifts and authority will strip the office of the Deputy Chief of Air of approximately 45% of its personnel.

Secretary Gates also approved a Franke committee proposal for the creation of an Assistant Secretary for Research and Development as one of the three assistant secretaries permitted under provisions of the Defense Department Reorganization Act of 1958.

He turned down, however, the committee's suggestion that the present post of Assistant Secretary for Personnel and Reserve Forces be abolished to make way for the new office and said the position of Assistant Secretary of the Navy for Financial Management will be eliminated instead.

The budget assignments previously handled by this office, Gray said, will be divided among the assistant secretaries "on a functional basis." The Under Secretary of Navy will continue to serve as comptroller.

Gates denied a committee recommendation that a Naval Technical Corps be established and the present "restricted line" category abolished in order to provide "equality of opportunity for promotion and career development" of the Navy's technical officers.

In rejecting the proposal, Gates said that the Chief of Naval Operations will be "directed to make a special review of the numbers, utilization and flag opportunity of officers in each category of the restricted line and submit his recommendations, with the views of the restricted line sponsors, to the Secretary of Navy via the Assistant Secretary . . . (for) Personnel and Reserve Forces by 1 November."

Recommendation for the merger of the Bureau of Aeronautics and Bureau of Ordnance was made by the Franke group, and approved by Secretary Gates, as a move to produce a "significant improvement in the total weapon systems effort within the Department of the Navy" and remove "troublesome areas of splintered responsibilities and split cognizance."

The Bureau of Weapons will inherit from its two predecessors approximately 4,400 military and civilian employes in Washington and another 200,000 in the field and be responsible for about 65% of the Navy's total research and development funds.

NASA Bidders Meet

Washington—Approximately 20 companies were expected to attend a bidders' briefing conference for the world-wide Project Mercury tracking-communications-data processing network scheduled for late last week at National Aeronautics and Space Administration's Langley, Va., laboratories.

Bids are due in approximately 30 days, with a target date of July 1 set for selecting the winning contractor. NASA hopes to have the system in operation within 12 months, but some industry sources believe this may be overly optimistic. Size of the contract is expected to exceed $20 million, perhaps ranging as high as $35 million or more, depending upon how much existing military facilities and hardware can be used.

NASA is outlining a broad operational requirement for precise, accurate tracking of the Mercury capsule, with continuous voice and telemetry communications and data processing. Bidders will recommend specific system configuration and hardware they believe necessary to accomplish the task. A number of the tracking and communication stations will be installed on shipboard. Others will be mounted in mobile vans to permit airlifting to different sites for future space probes using different orbits.

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NASA Details Contract Awards

NASA Budget

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NASA Details Contract Awards

Washington—Contracts have been let by National Aeronautics and Space Administration for two atomic space clocks and negotiations are under way for a third for use in satellite tests of Einstein's theory of relativity.

The theory that time moves more slowly in space because of a gravity factor will be tested by taking simultaneous ground and space readings from the clocks. Each of the three will operate with a different gas vapor.

One contract for a clock operating with ribidium vapor was let to the Bureau of Standards for $270,000. The other, to develop an atomic clock using cesium vapor, was let to the Massachusetts Institute of Technology for $50,000. Negotiations are under way with Hughes Aircraft Co. for development of a clock using ammonia vapor.

Total contracts let by NASA in April amounted to $27.6 million, with more than $1 million going to 10 universities for space instrumentation and fundamental research. Biggest part of the total, a $24 million order, went to Douglas Aircraft Co. for the Thor Delta, a three-stage launching vehicle.

Other contracts let in April include:

- **University of Maryland**—$60,000—to investigate the forces between atoms, molecules and ions.
- **Rice Institution**—$110,000—studies of performance and flow in test section of maximum Mach number wind tunnels; $50,000—research into physics of solid materials at high temperatures.
- **Rensselaer Polytechnic Institute**—$80,000—mathematical investigation of a variety of control systems.
- **University of California**—$120,000—study development of and chemical reactions occurring in a gaseous detonation wave.
- **Itek Corp.**—$170,000—develop sounding rocket instrumentation to sample upper atmosphere.
- **New York University**—$100,000—instrument two Aerobee-Hi rockets for neutron intensity measurements.
- **Army Ordnance Missile Command**—$150,000—radiation satellite payload.
- **Massachusetts Institute of Technology**—$70,000—gamma ray detection instruments and a prototype for a satellite.
- **University of Minnesota**—$70,000—construction of radiation detection instruments for a satellite and a space probe.
- **University of Michigan**—$80,000—satellite instrumentation for measuring intensity of radio noise levels above the ionosphere; $80,000—satellite instrumentation for measuring ultraviolet solar emission spectrum.
- **University of North Carolina**—$60,000—design and build a directional counter system to investigate the primary cosmic radiation for a satellite.
- **University of Chicago**—$300,000—build cosmic ray measuring instrumentation for a space probe.
- **Butler Aviation**—$150,000—modification of government airplanes used by NASA.
- **General Mills, Inc.**—$60,000—furnish nine 100-ft.-diameter plastic balloons for communication satellite tests. At least one of these is to be launched within a year as a communication satellite from which to bounce radio signals.
- **Aeronutronics Systems, Inc.**—$90,000—studies for Mercury tracking.
- **Radio Corp. of America Service Co.**—$60,000—planning studies for ground tracking and instrumentation facilities for Project Mercury.
- **American Potash & Chemical Co.**—$50,000—for 161,000 lb. of ammonium perchlorate for solid propellant research at NASA's Langley Research Center, Langley Field, Va.
- **Chance Vought Aircraft, Inc.**—$950,000—for four-stage Project Scout integration and a launcher (announced earlier).
- **General Electric Co.**—$50,000—furnish two telemetry and beacon antenna systems for Project Mercury.
- **Cincinnati Testing & Research Laboratory**—$80,000—tests on Project Mercury capsule heat shield.
- **USAF Air Materiel Command**—$120,000—five pressure suits for use in Project Mercury tests.

NASA Budget

Washington—House of Representatives last week approved a $480 million authorization for the Fiscal 1960 activities of National Aeronautics and Space Administration by a 294-128 vote.

The authorization is now pending before the Senate. Appropriations must then be obtained to implement the authorized programs.

A large part of the protest vote in the House was directed against a provision requiring NASA to obtain authorization for its programs for the next five years from the House and Senate Space Committees before obtaining appropriations.

The $480 million is divided: salaries and expenses, $94 million; research and development, $333 million; construction and equipment, $53 million. The largest research and development projects are: manned space flight, $70 million; 1,000,000-lb.-thrust single chamber engine; Project Vega, $43 million, and Centaur, $41 million.

NASA's Fiscal 1959 budget totals $404 million.

News Digest

Texaco, Inc. plans to acquire Experiment Incorporated, Richmond, Va., through an exchange of shares. Experiment Incorporated specializes in research and development of high energy propulsion systems (see p. 32).

Rex W. D. Smith, Jr., retired vice president-public relations of American Airlines died of cancer May 17 in New York City. Funeral services were conducted last Thursday at Gate City, Va., his birthplace. A former newspaperman (Chicago Sun, Detroit Times, San Francisco Examiner, Los Angeles Times, Paris edition of the New York Herald Tribune, Newsweek magazine and the Associated Press), Mr. Smith retired from American last June but continued to serve as a consultant. He headed the Army Air Corps Information Service in World War II and was discharged with the rank of colonel. He joined American in 1945.

First Atlas ICBM firing from Vandenberg AFB, Calif., last week was postponed indefinitely, pending successful firing on an operational-type Atlas from Cape Canaveral, Fla.

Expansion of industry's role in the nuclear ramjet program has been made, with Marquardt Corp. receiving a new Air Force contract to enable it to enlarge its work in this area. Marquardt is now working on a specific airframe to carry reactors of the type now being worked on in Project Pluto. The company also is studying more advanced reactors.

Lycoming T55 turbine engine was chosen last week as the powerplant for the Vertol YHC-1B Chinook helicopter under development for the Army.

Grumman S2F-3 anti-submarine warfare aircraft made its first flight last week. The new version of the Tracker has little external configuration change although engine nacelles have been lengthened in aft section, probably to house more advanced avionic gear.

High energy oxidizer research contract for about $750,000 has been awarded to Allied Chemical's General Chemical Division by Army Rocket and Guided Missile Agency for a study on advanced solid rocket propellants.

Dr. Louis Ridenour, 47, vice president of Lockheed and general manager of Lockheed Electronics and Avionics Department, was found dead last week in a Washington, D. C. hotel. Death was apparently due to natural causes.

CAB Defines Transpacific Ground Rules

Issues to be resolved and the geographical scope are detailed; final ruling may settle polar dispute.

By Robert H. Cook

Washington—Civil Aeronautics Board last week spelled out the issues to be resolved and defined the geographical scope of the complex Trans-Pacific Renewal Authority Case.

Major conclusions drawn by the Board as a result of a prehearing conference include:

- **Issues involving new** or added service between Alaska and other states should be excluded.
- **Proposals to name new** coterminals on the East and West coasts for Pacific service should be included.
- **Western boundary of the case** should be points in India and Pakistan.

Although the proceedings now involve 15 airlines serving the entire Pacific route area, final outcome of the case is expected to settle a 10-year battle between Pan American World Airways and Northwest Orient Airlines for control of the Great Circle Route to the Orient. Thirteen other applicants requesting either new service to Hawaii or extensions of present route systems, are Alaska, Continental, Hawaiian, Flying Tiger, Pacific, Pacific Northern, Seaboard & Western, South Pacific, Trans World, Transocean, United States Overseas, United and Western.

Board members voted to eliminate any question of service between Alaska and other states on grounds that a decision on the States-Alaska Case is still pending and said that the White House request for early consideration of Pacific route complexes should be interpreted as relating only to international services. Acknowledging the applications of Alaska and Pacific Northern as "defensive measures" in the event that a Northwest Airlines' proposal to add San Francisco and Los Angeles to its Alaska-Orient route is included in the case, CAB added a proviso that, should such a new terminal be granted, appropriate restrictions would be placed on the new authority.

Board approval of requests for new coterminals on both coasts has a direct bearing on the application of Pan American, for although the carrier has authority to utilize the shorter Great Circle Route out of Los Angeles and San Francisco, it contends that the route is uneconomical without stops at Portland and Seattle. Pan American has listed its California cities, along with Tacoma and Seattle, as desired coterminals on a transcontinental route connecting its present route system with New York and Chicago.

In addition, it is seeking the removal of a restriction requiring a stop at Hawaii on flights picking up or discharging passengers in Tokyo. The airline also wants Fairbanks, Alaska, named as an intermediate point on flights to Tokyo from New York, Washington, Detroit and Chicago. Approval of these cities as coterminals would permit Pan American to compete directly with Northwest on a Tokyo route either via Northwest's present Great Circle Route out of Seattle or the "inside Great Circle" from Minneapolis.

Pan American has emphasized the importance of these stops in view of the speed advantages of jet flights, and Board members noted that "it is even more appropriate now with the advent of long-range jet aircraft." Inclusion of this issue is based upon a proviso that local traffic will not be carried between these cities.

Board members denied requests by five airlines that service between Hawaii and the mainland be eliminated from the scope of the case in the interest of saving time. Arguments that pending statehood for the island will remove Hawaii from an international classification requiring presidential approval of any new routes were regarded by CAB as having no effect upon the "stern realities of the mainland-Hawaii traffic" and its importance as a traffic generating point to the Orient.

Western Boundary

In a discussion regarding establishment of a western boundary on the case, CAB rejected a Northwest proposal calling for a Tokyo-Hong Kong-Manila line. Such a line, the Board said, fails to cover the entire Pacific route complex in view of the Pan American routes which currently extend beyond to India and Pakistan. A Pan American bid to have Moscow named as a coterminal was rejected because of the extreme length of the route segment and doubt as to the future use of the routing.

Trans World Airlines' request for an extension of its route system from Ceylon to Shanghai, Manila and Tokyo will be considered as an amendment proceeding on the carrier's transatlantic certificate.

Other issues to be included in the case are applications by Flying Tiger and Seaboard & Western for property and mail-only authority between the U.S. and points in the Orient.

ALPA Charges 'Gestapo' Tactics In Dispute Over Cockpit Duties

By L. L. Doty

Washington—Air Line Pilots Assn. last week warned that Federal Aviation Agency's "childish Gestapo" tactics designed to make pilots remain in their cockpit seats at all times during a flight would result in a complete breach with the agency's inspectors.

In a sharply worded letter expounding a pilot's right to roam aloft according to his own judgment, ALPA President Clarence N. Sayen told FAA Administrator E. R. Quesada that pilots could not be expected to remain strapped in their seats on flights lasting up to, and sometimes longer than, 12 hr. He added: "Our kidneys and circulatory systems are not that good."

Sayen accused FAA inspectors of timing the length of visits by pilots to the passenger cabins of aircraft and filing violation reports against them. He charged that the letter Quesada distributed last March to all air carrier presidents calling for more pilot vigilance (AW Mar. 30, p. 54) has resulted in a "program of petty and childish harassment."

Quesada Rebuttal

Quesada said he planned to make a public reply to the letter and said in an interim statement that the meaning and intent of safety regulations would be "firmly and fairly" applied. He added that the FAA would continue to enforce the Civil Air Regulation (part 40)

covering occupancy in the cockpit.

Sayen made no direct reference to this regulation in his statement to Quesada but charged that the FAA administrator's letter to the airline presidents "has had the effect of a new regulation." He added that this has been achieved "by a general assertion" by FAA without defining terms and then noted:

"You have not specified the maximum time that can be spent in the passengers' compartment, how many trips can be made to the passenger compartment, what is a justifiable reason for visiting the passenger compartment or the many other indistinct areas involved." He then concluded:

"Yet the representatives of the FAA are attempting to apply some sort of exact measurement to this general rule and to substitute their judgment for that of the pilot in command in this undefined area. Such treatment of mature people is, in my view, plainly ridiculous."

In his March letter to the airline presidents, Quesada called attention to the current rash of "near-miss incidents" and urged pilots to maintain a thorough and vigilant watch for other air traffic at all times. He added:

"It has been my personal experience, when riding with commercial air carriers, that too often the pilot is back in the cabin talking to passengers or engaging in other endeavors not essential to his duties. This practice must cease forthwith."

Quesada then cited Part 40:354 of the Civil Air Regulations which requires that crew members remain at all times at their stations during takeoffs, landings and en route operations except when the absence of one member is "necessary in connection with his regular duties."

Last month, the regulation was amended to read ". . . except when the absence of one such flight crew member is necessary for the performance of his duties in connection with the operation of the airplane."

In adopting the amendment, FAA explained that it wished to clarify the meaning of the phrase "regular duties." It said the phrase was not intended to encompass public relations or other activities unrelated to the operational safety of the airplane.

It emphasized that the absence of any flight crew member from the flight deck reduces "unnecessarily the degree of vigilance, attention to duty and availability for emergency action required for the operation of modern aircraft under conditions of high density traffic."

In his letter to Quesada, Sayen said:

• **Pilot in command** has a statutory responsibility for safety in the cabin.

• **Pilots have been encouraged** to make periodic visits to the passenger cabin to "observe that sound safety practices were being observed, to promote good will, and to determine that passengers were receiving proper service."

• **Pilots' "physical needs"** necessitate visits to the cabin because of the location of the rest rooms. ". . . passenger capacity in relationship to lavoratory capacity" being what it is often requires the pilot to wait for "long periods in order to use the facilities."

• **Sensible pilots leave** their seats "to exercise," thus restoring circulation and retaining alertness. Only place for this "break" is the passenger cabin.

• **Many airlines are now serving** alcoholic beverages and "the responsibility to maintain law and order aboard the aircraft, even under such conditions, rests with the pilot in command."

The ALPA head said that ALPA had made recommendations in the past for measures that would ensure two qualified pilots on the flight deck at all times but charged: "to this date, the only concrete action that has been taken by the FAA was your letter regarding the pilot in command visiting the passenger cabin and the recent actions by your inspectors."

In this connection, Sayen said his group had pointed out the regulation which states that only the pilot in command is required to be qualified in the particular aircraft being flown. He said that ALPA has urged that the regulations be revised to require the same qualifications of the copilot.

He said that under present regulations if something should happen to the captain, the copilot may not be qualified on the aircraft involved and the "third man" is not required to fly at all.

Earlier in the letter, he threatened: "The net result, unless some common sense is injected into this situation very soon, promises to be a complete deterioration of respect for the inspectors of the FAA and a complete breach in the relationship between these individuals and the pilots with whom they work."

CAB Upholds Mutual Aid Pact

Washington—Civil Aeronautics Board, in a 4-1 decision, last week approved the mutual aid pact signed by six airlines in October.

The majority opinion found that the pact was not adverse to the public interest nor in violation of the Railway Labor Act. It did delete from the agreement a provision which required a carrier grounded by a strike to divert its traffic to other members of the pact.

The agreement provides for mutual assistance in the event any party's flight operations are shut down by a strike called to enforce union demands in excess of a presidential emergency board's recommendations or before all pre-strike procedures have been exhausted. Carriers covered by the pact are American, Capital, Eastern, Pan American, Trans World and United.

In a 25-page dissension, Board Member G. Joseph Minetti took sharp issue with the majority opinion and strongly criticized its legal findings in the case.

Minetti said the agreement strikes at the "heart of the Railway Labor Act" which, he added, "embodies the wisdom acquired through years of trial and error in labor legislation." He concluded that the "public interest is not served by permitting management to pit itself openly and adamantly against the good-faith bargaining with its employes."

In its opinion the Board found that, although the agreement increased management's abilities to withstand the economic impact of strikes as union benefits cushion the economic effect on employes, it does not affect the companies' duties to bargain in earnest.

Minetti said he found no evidence that union assistance to employes was adequate to furnish the strength to prolong a strike. He added that funds such as the payment of $10 a week paid out of the union strike fund during the Capital strike did not justify the payment of huge sums to a struck carrier.

He noted that sharing profits with a competitor is "entirely inconsistent with competition" and added that "the carriers have been certificated to compete with, not subsidize, each other."

The majority found that experience in recent strikes suggested that there will necessarily "be present potent factors precluding carrier complacency around the bargaining table."

It also said that "the carrier involved in the dispute may bargain without reference to the views" of other parties and, if struck, is entitled to aid despite its "bargaining posture among other parties" to the agreement.

In connection with union contentions that the agreement would force the unions to accept emergency board recommendations, the CAB majority noted that Railway Labor Act is "silent" on private efforts to compel acceptance of recommendations of emergency boards. It added:

"Should the carriers fulfill the union predictions and subvert the agreement in violation of the law, aggrieved parties remain free to pursue the same legal remedies which were available prior to our order."

Supersonic Airliner Flight Plan Outlined

Washington—Unconventional problems that airlines can expect to encounter in flight operations of supersonic aircraft (AW Feb. 2, p. 38) were detailed by Wellwood E. Beall, senior vice president, Boeing Airplane Co., in a talk during the 21st Aviation Writers Assn. convention here. In his report on supersonic turbojets, Beall described a theoretical flight from Paris to New York in one of the high-speed transports of the future:

"The flight plan, based on a long-range cruise, has been set up for climb to 65,000 ft., followed by climbing cruise as fuel is consumed, reaching an altitude of 75,000 ft. just prior to descent. Climbing along the path for minimum fuel consumption, the airplane would reach sonic velocity at an altitude of 20,000 ft. about halfway to the coast of France. The sonic boom heard on the ground from an airplane this low would be objectionable. The climb path, therefore, is programed to reach sonic velocity over the English Channel at an altitude of 30,000 ft. Intensity of boom will thus be substantially reduced. A 50 kt. headwind is fairly typical of winter weather at 60,000 to 80,000 ft. The effect is quite small for an airplane of this type because of the short mission time.

"Our trip time will be only three minutes longer because of the wind. Reserve fuel requirements provide that sufficient fuel must be aboard to fly an additional 10% of the normal trip time, plus fuel to fly to the most distant alternate plus 30 min. holding at 1,500 ft. above the alternate. The alternate for our flight is Washington, D. C., and the reserve fuel requirement is about 8% of the takeoff weight as compared to 5¼% for current subsonic jet airplanes.

Possible Emergency

"Emergencies must be taken into account, such as cabin decompression which would force the airplane to descend to an altitude which passengers can tolerate.

"At this lower altitude, say 15,000 ft., the cruise would be continued at subsonic speed. At this lower altitude, with the 8% reserve fuel allowance, 1,400 mi. out is the maximum point from which return could be made to the starting point. Also, unless the airplane has reached the 2,100-mi. mark before decompression occurs, it would not have sufficient fuel to complete the trip. However, should decompression occur halfway between Paris and New York, the airplane would still have an 1,100 naut. mi. range capability to reach alternates such as Gander, Goose Bay, Keflavik, Shannon or Santa Maria. A similar situation exists with two engines failed.

"After takeoff our crew will experience a greatly compressed time in which to accomplish its job. As designers and operators we have had to decide which jobs to give the crew of our subsonic transport and which to delegate to automatic devices. . . . The supersonic transport will undoubtedly have more automatic controls. However, back-up manual controls meeting the requirements for pilot proficiency can and will be developed.

". . . The ground run is comparable to that of the subsonic jet. However, the acceleration is somewhat greater. The pilot elects to accomplish his climb by preprogramed tape operating through the autopilot. The time to climb to the initial cruise altitude of 68,000 ft. and accelerate to Mach 3 is about 15 min. In order not to exceed cabin differential pressure limit of 10.5 psi., the cabin altitude is increased at a rate of about 500 fpm. During climb and acceleration the relative slant of the cabin floor is about 12 deg. You won't see the stewardesses walking about in high-heeled shoes.

"Navigation equipment includes the best of that available on subsonic jets, plus digital computers which avoid the necessity of the pilot solving a mathematical problem to arrive at his position, which is changing about 30 mi. every minute. The airplane position is automatically reported in code to recording equipment on the ground. Weather information is received by a push-button selector which radios coded standard requests. Should a decompression emergency arise, pressurization of the cabin during descent would be accomplished by ram-air cooled by water spray. Oxygen service, as incorporated in subsonic jets, would be provided in addition.

". . . Fuel reserves provide for subsonic cruise at 15,000 ft. altitude to a number of alternates. At 700 to 800 mi. out from New York the pilot turns his attention to the terminal traffic and landing clearance problems. The pilot is faced with two possibilities which may alter his flight plan: first, rerouting to an alternate, second, delay in landing due to traffic or runway congestion. However, air traffic control is all in order, and we have permission to land at Idlewild without delay. In order to eliminate any passenger discomfort, the limit of rate of change of cabin altitude will be 300 fpm. Since the cabin is at 8,000 ft., this establishes the minimum descent time at 27 min. Within this, time limitation of descent is scheduled so that minimum fuel will be burned. In order to do this, the airplane must be operated near maximum lift-drag ratio."

Speed Schedule

"The speed schedule will be approximately as follows: first, the airplane is decelerated to Mach 2.2 at cruise altitude because the change in altitude from maximum lift-drag ratio is relatively small in this Mach number range. Next, an approximately linear variation of Mach number with altitude is followed until Mach .95 at 55,000 ft. is reached. Mach .95 is maintained down to the altitude for 300 kt. equivalent airspeed. The final part of the descent is at 300 kt. constant equivalent airspeed.

"In addition to the altitude speed schedule, the pilot will fly in a definite corridor in the high traffic density areas near New York. Since the flight crews will have little time to work with paper maps and instrument procedure books, the desired map will be projected on a screen on the flight panel. The airplane's position, determined from the navigation computer, is also projected on the screen."

Best Path

"The best path to a straight-in approach will be used. If the weather is good, the pilot will probably do the job manually. If the weather is bad, he may fly manually down the glide beam but will probably put it on automatic so he can carefully monitor the over-all situation. Automatic approach and landing will be handled by slaving ILS and autopilot to a ground computer which receives intelligence by looking at the airplane with K-band radar. This system has been tried on our subsonic jets with considerable success. The flight of approximately 3,200 naut. mi. from Paris to New York has taken about two and one-half hours. Sixty percent of this time was spent at Mach 3.

Award to Tupolev

Andrei Tupolev will receive the Gold Medal of the Federation Aeronautique Internationale at its annual meeting in Moscow this week for his design of the Tu-104 jet transport that has been in scheduled service on Aeroflot for the past three years. Total of 51 countries will be represented at the FAI meeting from May 25 to June 1, with the Central Aero Club of the USSR headed by Yevgeny Stepanov as host. U. S. delegation will be headed by Jacqueline Cochran who is also FAI president.

"It is obvious that with this kind of speed fewer aircraft will be required to do the equivalent work of subsonic aircraft. A fleet of four Mach 3 transports shuttling between New York and Paris would make a total of six flights each way daily. Turnaround time is approximately two and one-half hours. Maintenance can be performed at either end of the line.

"Also, adequate time is available in either New York or Paris to accomplish overhauling on a progressive basis. It should not be necessary to withdraw airplanes from scheduled operation for periodic overhaul.

"The four airplanes flying the New York-Paris schedule will provide a fleet utilization of seven and one-half hours per day. Three of the airplanes would have long lay-overs at New York during the evening hours. These lay-overs are scheduled to avoid early morning arrivals in Paris. These New York lay-over periods might be utilized for short north-south flights to better suit local time of day. A schedule of Miami flights with a block time of one hour would increase fleet utilization to 9 hr. per day.

"The 950 naut. mi. New York-Miami flight is somewhat shorter than the minimum distance at which a supersonic transport can compete with subsonic types in terms of direct operating cost. However, use of the supersonic transport for this and even shorter distances is considered feasible to fill in schedules if the airplane would otherwise remain on the ground because of arrivals or departures at the other end of the normal route coming at inconvenient times."

Local Service Lines Cast Vote In Plan for New Subsidy Rate

Washington—Local service carriers cast a majority vote of approval last week on the basic elements of a new Civil Aeronautics Board class rate formula subsidy plan designed to replace today's complex mail rate proceedings and eventually free the small airlines from subsidy dependence (AW May 11, p. 40).

Members of the Association of Local Transport Airlines, which has long pressed for such a plan, met with consultants of United Research, Inc., employed by ALTA to study and recommend any needed changes, and later discussed suggested refinements with the CAB.

Nine of the 13 ALTA members endorsed the CAB staff proposal, with some modifications suggested by United Research as both "desirable and feasible." Three airlines, while approving the theoretical principle of the class rate proposal, questioned the ability of one class formula alone to provide both adequate air service and a reasonable after-taxes profit for each individual carrier. One carrier considered the present mail rate policy adequate with modification in administration, said ALTA.

Utilizing the carrier comments submitted last week, along with many of the modifications recommended by the private research firm, the Board will rework its basic plan and hopes to resubmit it to the local service airlines by July 1.

Basic operation of the class rate formula revolves about monthly subsidy payments keyed to a per route mile rate determined by flight frequencies over a route and assumed passenger load factors. To this would be added a station subsidy plus an allowance of 10% of operating revenue (less subsidy) deducted from the total mileage and station subsidy payments.

Carriers favoring the new plan told the Civil Aeronautics Board they feel that a United Research recommendation calling for a division of station expenses, with one portion allotted on the basis of the number of stations served and the other on the basis of mileage flown, should be adopted.

Methods of adequately covering the cost of integrating new flight equipment posed one of the largest questions for the small airlines. Current class rate plan makes no distinct provision for the heavy expense of crew training, maintenance and operational costs, none of which can be accurately predetermined. While a United modification does allow a higher operating cost per mile for such equipment as the Fairchild F-27, Martin 202 and Convair 240 and 340, it is based on a Douglas DC-3 "yardstick" which many airlines fear would not adequately cover initial costs.

Many observers point out, however, that since the proposed formula would vary only on the basis of flight frequencies, any added costs experienced during the early stages of inaugurating new equipment might be recaptured at a later date through higher subsidies resulting from more experienced and economical operation of the new aircraft. Board spokesmen said they expect to build in a more detailed formula to cover this item.

ALTA members also backed the consultant's recommendation calling for subsidized route mileage which would provide adequate flight frequency without the necessity of subsidizing each route segment independently. United Research suggested that on any route division containing several segments, the number of flights subsidized be multiplied by the applicable number of route segments.

Efforts of United Research to make allowances for varying lengths of local service flights were considered unimportant at this time by the carriers since, they said, most of the present mileage is still flown in DC-3 equipment. They added that greater importance will be attached to such an adjustment when local service fleets are modernized on a larger scale.

The carriers also agreed to the necessity for an experience adjustment whereby the future subsidy of an airline with high past profits would be reduced, but discounted the need for a 10% revenue deduction in favor of adding this phase to the rate after the new plan has had a test.

Since local service operations are basically similar, the proposed class rate is expected to meet their collective needs as a group but will not be applied to either Alaskan carriers or helicopter operations, both of which have operational problems unlike those of local service operators, CAB said.

DC-8 Being Repaired After Hard Landing

Los Angeles—Major damage to the number two Douglas DC-8 received in a hard landing at Edwards AFB consisted of loss of number one engine and pylon and downward buckling of the fuselage just aft of the wing trailing edge, according to a Douglas spokesman.

There was no fire and no damage to wing or landing gear. No fuel leaks have been found in wing tanks since the incident and the tires did not burst under impact. The fuselage buckled in the vicinity of a belly cargo door. Work has already begun on repair and restringing of the buckled section. Airplane, engines and systems functioned normally at the time of the landing. Number one pylon separated from the wing cleanly without allowing damage to spread into wing skin and structure.

Number two DC-8 is a 265,000-lb., maximum gross weight domestic version powered by Pratt & Whitney JT4 (J75) engines and will be delivered to United Air Lines when certification is complete. Douglas does not expect temporary loss of the airplane to slow certification very much since there are five others in the program and two more which will enter the program when completed.

Federal Aviation Agency pilot Joe Tymczyszyn and Douglas chief test pilot Arnold Heimerdinger taxied the airplane off the runway before realizing the degree of damage.

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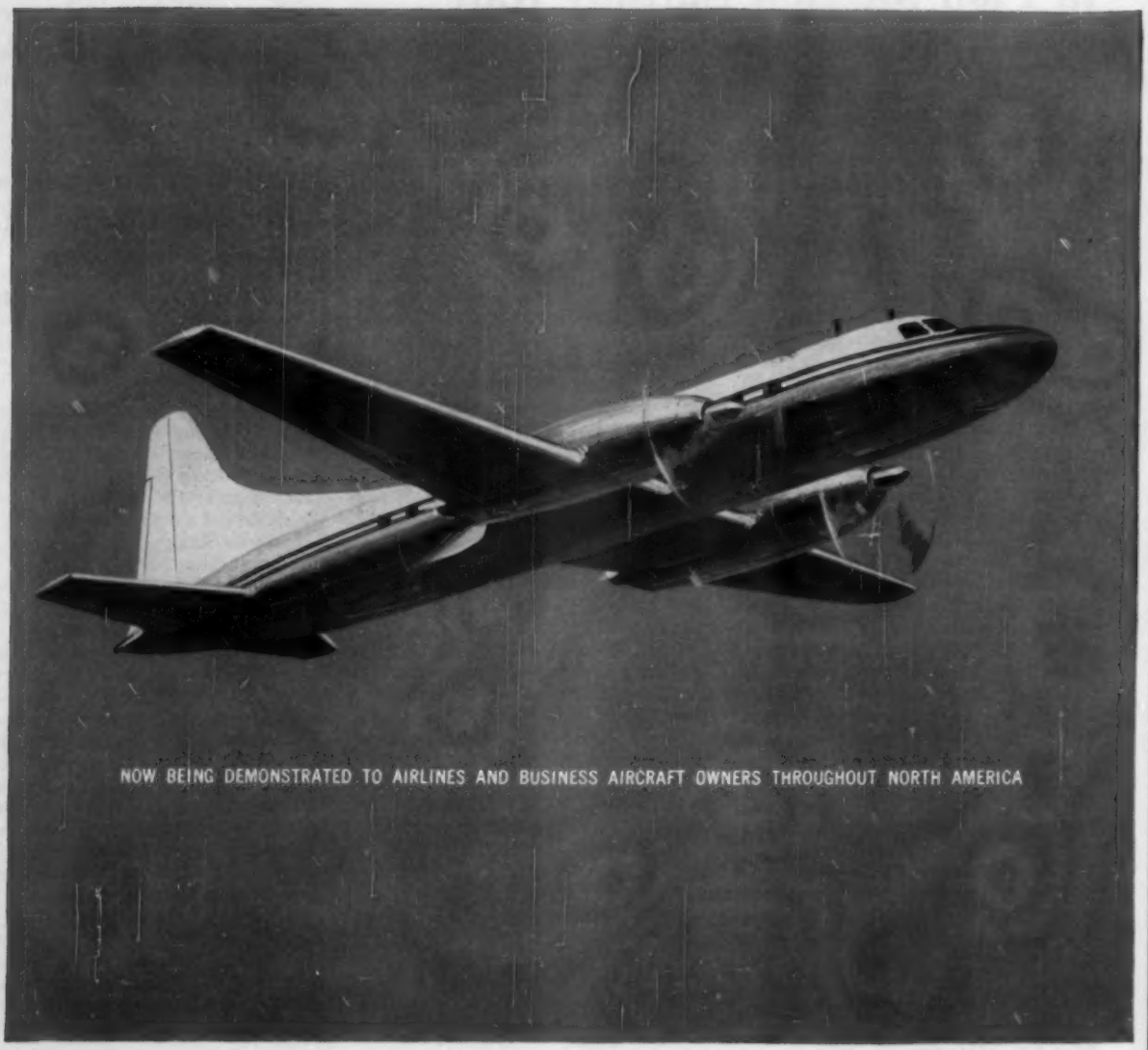

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- FASTEST IN ITS FIELD—Up to 340 m.p.h. at 20,000 ft.
- GREAT FLEXIBILITY—Equally at home in a series of short hops as it is on medium ranges and at all altitudes up to 20,000 feet . . . operates out of all close-in and most smaller fields.
- LOW OPERATING COSTS—As economical as a piston aircraft in stages as short as 80 miles . . . simplified maintenance lowers cost of training.
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- GOOD EARNING ABILITY—Profitable even with moderate payloads.
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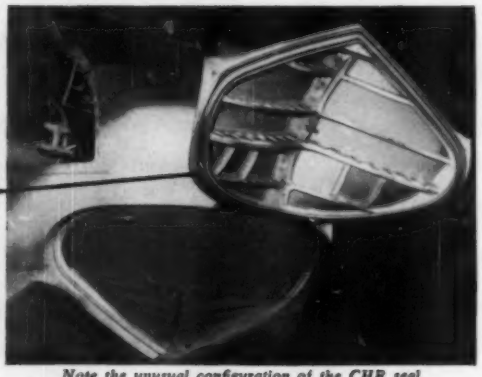
CHR SEAL SOLVES PROBLEM ABOARD NAVY'S FIRST AMPHIBIOUS HELICOPTER

Water pressure during take-offs and landings of the new Sikorsky HSS-2 necessitates positive sealing of the lightweight service door to the electronic compartment.

Water-tight sealing over the door's complex contour is achieved with the unique CHR seal shown. Specially designed to withstand the varied water pressures encountered in service, this tough seal is made of silicone rubber with a dacron reinforced fabric cover. A special CHR silicone sponge rubber compound runs through the center rise of the seal insuring a water-tight seal on the striker surface. The two bulbs on either side of the center rise, act as secondary seals and take up any gap between metal surfaces of door and bow.

Though lightweight, this effective seal can withstand the extreme weathering, wear and abrasive conditions encountered during flight operations of this remarkable aircraft.

SIKORSKY'S HSS-2 — Navy's first, all-weather, twin-turbine powered amphibious helicopter, designed for anti-submarine service.



Note the unusual configuration of the CHR seal on the lightweight electronic compartment door. This was required by its complex contour.

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Durfee Cites Jet Fares as CAB Problem

Washington—Aviation's dynamic growth has created new and urgent projects for the Civil Aeronautics Board, Chairman James R. Durfee told the House Independent Offices Appropriations Subcommittee.

Major problems confronting CAB, Durfee said, include:

• "**Impact of jets** is certain to require substantial route and service pattern changes and will present new problems with respect to fare levels and fare structures. Failure of the International Air Transport Assn. to agree on the question of a jet differential last fall and jet fare differential cases already presented to the Board are only a beginning.

• "**There is a need for a major** review of over-all U. S. international aviation policy as distinguished from individual negotiations with other countries. There are about 50 countries with which the United States has international air agreements.

• "**Increased level of local** service subsidy, together with the increasing number of requests related to adequacy of service, particularly from small communities, indicate the urgency of finding new ways to promote traffic growth."

Durfee told the subcommittee that the Board is "simply not now prepared, in terms of staff and related resources, to adequately meet these problems." For this reason, coupled with an already heavy workload, Durfee told the subcommittee, CAB is asking for substantial increases in its Fiscal 1960 budget for salaries and expenses and personnel.

CAB budget estimates for Fiscal 1960 total $70,118,000. Of this, $7.5 million is for salaries and expenses, an increase of $1.1 million over the adjusted Fiscal 1959 budget, and $62,618,000 for payments to air carriers. In Fiscal 1959, Congress appropriated $40.7 million for these payments, and an additional $18 million was asked under a supplemental request now pending in Congress.

Durfee said the total subsidy accruing in Fiscal 1960 is estimated at $61,786,000, of which $48,958,000 will be required by local service carriers operating within the continental U. S. Of the remainder, $7 million will be required by Alaskan carriers and $5 million by helicopter operators.

The CAB program to eventually reduce subsidy requirements of local service carriers, Durfee said, involves assisting in the financing of more modern equipment; strengthening of carriers by additional major route awards; eliminating the weakest traffic points, and allowing greater operating flexibility by revising the mail rate machinery.

Durfee said 116 new positions are requested for Fiscal 1960 to bring the total number of employes from 730 to 846. Of the 116 new positions, 102 will be for supplementing the staff handling economic regulatory matters, which he said are growing in both volume and complexity, and 14 for supplementing safety activities related primarily to investigation and analysis of light-plane accidents.

Reasons for increasing the staff, Durfee said, include:

• **Virtually all work now** is on a priority basis, with priorities within priorities.

• **Individual cases or projects** now under way are being unduly delayed to a degree that is highly prejudicial to the public interest.

• **Much important work** must be indefinitely postponed and other work, such as planning and preliminary research on new developments, cannot be programed at all.

Later, before the same subcommittee, Gen. Elwood R. Quesada, administrator of the Federal Aviation Agency, said the FAA hopes to develop an airspace system which would eventually lead to elimination of airways.

He said FAA feels that the existence of an airway structure causes in itself traffic to be congested.

"If and when we develop a reconnaissance system that can tell us where the aircraft in flight are with sufficient accuracy," he said, "then we can take that information, process it and safely

Passengers Board 707 Through Covered Ramp

Passenger boarding device adopted by American Airlines at San Francisco, Calif., allows passengers to board Boeing 707 jet transports directly from second-floor departure rooms in the terminal without being exposed to weather. Designated "Jet Airwalk," the unit operates as a shuttle corridor slung from a monorail and is electrically operated. Airwalk, which costs $35,000, will be installed later this year at New York and Los Angeles.

separate the aircraft by semiautomatic means." Quesada said FAA is moving forward to this system through a development program and hopes production contracts can be let by Jan. 1, 1963.

In a recent speech, Durfee said taxes collected from air transport have consistently far exceeded civil aviation appropriations in the last few years, in pointing up what he called the "Las Vegas lesson" that safety and economic stability in aviation are very much interdependent.

The Grand Canyon and Nellis AFB midair collisions of 1956 and 1958 were both historically associated with Las Vegas and are commonly used examples of inadequate air traffic management springing from financial neglect of earlier years. Durfee noted the depressing effect upon airline traffic after the Grand Canyon crash and blamed much of the recession-bred traffic slump of early 1958 upon the Nellis and Brunswick collisions.

Durfee used the "Las Vegas lesson" and discrepancies between aviation taxes and the money spent on the tools of aviation safety in support of the Fiscal 1960 $500 million Federal Aviation Agency budget request (AW May 18, p. 25).

MATS Will Contract $70 Million With Carriers in Fiscal 1960

Washington—Military Air Transport Service plans to hold the line against any expansion of its airlift capability and will contract for $70 million in commercial airline services during the coming year, according to Defense Department testimony before the House Military Operations Subcommittee.

Philip B. Taylor, Assistant Secretary of the Air Force for Materiel, said that the introduction into MATS of larger aircraft will be countered by a reduction in flying time to a maximum of five hours a day, as well as the retirement of obsolescent types.

MATS Contracted

MATS contracted for $71 million in commercial services in Fiscal 1959.

Meanwhile, it was reported that the Defense Department will submit a study evaluating the role for MATS in peacetime, limited war and all-out war to the White House in mid-June. Such a report was requested by the President last July. The study is being made under the direction of the office of Perkins McGuire, Assistant Secretary of Defense for Supply and Logistics. It will consider the prospect for a lessened requirement for MATS and Civil Reserve Air Fleet capability with the shift from manned bombers to missiles in the striking force.

Other points made at sessions of the subcommittee, headed by Rep. Chet Holifield (D.-Calif.), included:

• **MATS now has 23 Douglas C-133s** and is receiving deliveries at the rate of one a month. The original program for 109 has been reduced to 50. One of the factors, USAF reported, was the plane's high fuel consumption. Eight of the planes have been restricted to overland use in peacetime. Air Force said this action is due to "temporary difficulty in quality control in connection with inspecting of overhauled engines for the C-133."

• **Ten cargo jets** Air Force plans to purchase with Fiscal 1960 funds will be used to provide an overflight capability in the Pacific area. USAF originally planned to accomplish this with the C-133s. Taylor said the jets are "not for routine lift" but "will be used primarily to support effectively the initial stages of a U.S. nuclear force."

• **An aircraft to replace** the obsolescent Douglas C-124, considered the workhorse of the MATS fleet, is now being evaluated at the Air Materiel Command. "The aircraft we need must retain and improve the C-124's rugged versatility," Taylor told the subcommittee. "It must be capable of carrying both general cargo and vehicles, as well as troops; it must have good loading, takeoff and landing characteristics, and it must operate intercontinentally at a lower ton-mile cost than currently available transports."

• **Modernization of the support** squadrons of Strategic Air Command and Air Materiel Command is now under consideration.

• **MATS will continue** its present policy of letting commercial airlift contracts by competitive bidding and without regard to whether carriers are participants in the Civil Reserve Air Fleet.

• **Operations boards to control** CRAF operations in the Pacific and Atlantic—in accordance with MATS instructions—have been established since Civil Aeronautics Board approved on April 13 the participation of the air carriers. Taylor termed establishment of the boards "a major achievement in creating a ready CRAF in being." A "paper exercise" to determine the efficiency of CRAF will be conducted at some unannounced time in the near future.

• **There are still many** unmodified cargo aircraft in CRAF, Taylor said, because the Air Force has been unable to reach contract agreements with the airlines. "This reduces the over-all cargo capability of CRAF within the early stages of an emergency, as we estimate that it will be from 15 to 30 days after activation before these unmodified aircraft will be capable of over-ocean operation."

DC-9 Proposal

Los Angeles—Douglas Aircraft Co. is expected to launch a sales campaign supporting its projected DC-9 turbofan transport aircraft within four to five weeks.

Four airlines—American, Eastern, Pan American and Trans-Canada—have expressed interest in the proposed aircraft and some have indicated by letter that they might purchase a fleet if price and terms are right. The aircraft has been discussed for the past two years with some 30 potential customers. Decision to build will depend on how many commitments the manufacturer is guaranteed.

Delivery date will probably be 1963 and the plane may go into the 140,000 lb. gross weight class. It probably will be a scaled-down version of the DC-8, almost identical in configuration, aerodynamics, angle of sweep and airfoil cross section.

Plane will be powered by four turbofan engines, probably in the 9,000 lb. thrust class.

Boeing also has a turbofan transport in design study designated the 727. The aircraft, which is being worked out in a two, three and four-engine configuration, will be in the 70,000 lb. gross weight class.

Canadian Firm Insures Loans for CL-44

Washington—Loans covering sale of 15 Canadair CL-44 turboprop cargo transports to Flying Tiger Line and Seaboard and Western Airlines (AW May 18, p. 41) will be insured by the Export Credit Insurance Co., a Canadian government agency.

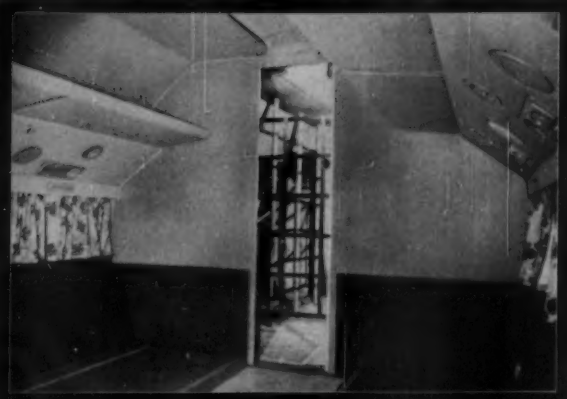
The organization, which was recently authorized to insure loans to companies in the U. S., will insure notes taken from the two airlines up to 85% of the balance due after down payments of about 20% of the total cost. Backed by the insurance, Canadair will be in a position to rediscount the notes at Canadian banks.

Flying Tiger has purchased 10 of the aircraft at $55 million and Seaboard has contracted to buy five of the planes at $25 million (AW May 18, p. 41). Down payments amount to 10% at the signing of the contracts and another 10% of the total purchase price on delivery of the first aircraft.

Ground equipment at Moscow's Vnukovo Airport has been considerably modernized for Aeroflot traffic. Passenger bus (right) and fuel tank-truck are of fairly recent design. Off-airport ticket agency (above) displays Tu-104 jet service advertisement.

Aeroflot Improves Airport Ground Handling System

Passenger luggage moves into Tu-104B cargo hold in preparation for Moscow-Leningrad flight. Luggage ramp is hydraulically operated and is improvement over fork-lift previously used (AW June 30, 1958, p. 29). Airport control tower still has brocade curtains on windows.



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Specially designed hat racks and cold air system quickly removable in sections.

Passenger windows added to cargo doors . . . installation of radar system, including radome.

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AiResearch Aviation Service modifies to specific airline requirements

The cargo-passenger convertible DC-6A allows a change from full passenger to cargo-passenger configuration on three hours' notice, and full passenger to full cargo changeover in 24 hours. Literally three airplanes in one, it assures operators the best use of present equipment.

Modifications include installation of seats on tracks . . . galleys and bulkheads designed for quick and easy removal . . . passenger lavatories and water systems.

Other major modifications for DC-6 and DC-7 aircraft include:

- Conversion from first class to tourist seating, or combinations of the two separated by a movable bulkhead.
- Radar installation including design of system and addition of radar nose . . . also radio, navigation and other communication and electrical systems.
- Extended range and increased gross weight of DC-6B.
- Performance of any required Douglas Service Bulletins.

Modifications have been performed for leading airlines including American, Canadian Pacific, Pan American, Japan, Hawaiian, Swissair, Sabena and others. AiResearch's more than 150,000 square feet of floor space represent the finest conversion, modification and servicing facilities available.

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SHORTLINES

▶ **American Airlines** reported that it has carried over 100,000 passengers in its Lockheed Electra turboprop transports since inauguration of service on Jan. 23 and has flown over 68,892,000 passenger miles in the aircraft. Nonstop service from Boston to Los Angeles in Boeing 707 jet transports is scheduled to begin June 1 on a one flight per day basis. Flight will carry 56 persons in first-class lounge, 56 in tourist class.

▶ **Delta Air Lines** has instituted complimentary food service on day-coach flights, serving hot meals, box lunches and breakfast.

▶ **Independent Airlines Assn.** has been selected to fly 1,299 of the U. S. Military Academy cadets to training sites during the summer. Seven IAA member airlines will participate.

▶ **Nord-Aviation of France** recently delivered its third Noratlas 2501 transport to the Israeli airline Arkia, boosting the total number of Noratlas deliveries to 207.

▶ **Northwest Airlines** flew 143,690 passengers 105,600,000 revenue passenger miles during April, an increase of almost 40% over the same month of last year. Total domestic and international revenue passenger miles increased 16.4% over April, 1958, to approximately 132,134,000.

▶ **Pan American World Airways** reports a first quarter net loss of $2,499,000, a decline from the 1958 first quarter loss of $3,360,000. Gross operating revenues for the period were $71,758,000, an increase of $7,450,000 over the 1958 total of $64,308,000.

▶ **Varig Airlines** of Brazil is planning to use Sud Aviation Caravelle jet transports alongside its Lockheed Super Constellation equipment on the Brazil-New York route beginning in September. Caravelles will have to make more refueling stops than the Constellations, but the airline hopes the attractions of jet flight will overcome passenger resistance to the extra stops.

▶ **Port of Oakland, Calif.**, has approved a new passenger terminal at a cost of between $4 and $5 million as a major feature of the $17,500,000 expansion program of Metropolitan Oakland International Airport.

▶ **United Air Lines** will accelerate its service between California and Hawaii beginning June 1, providing a total of 30 round-trip flights each week.

AIRLINE OBSERVER

▶ Watch for a move by a major U. S. trunkline to purchase a fleet of Convair 340 aircraft powered with Allison turboprop engines to cover short-haul segments of its routes. Pacific Western Airlines, an Alaskan carrier, recently completed evaluation of a Canadair 540 powered with Napier Eland turboprops and is expected to make a decision on a re-equipment program within the near future.

▶ **Airline business in April fell off slightly from the all-time high set in March but continued to hold close to the sharp upward trend that started early this year. Revenue passenger miles for April dropped to 2.25 billion from the 2.29 billion recorded in March. The April figure, however, was up 11% over the previous April—one of the three largest monthly gains reported since late 1957. Available seat miles in April were slightly less than those operated in March but were 9.4% over the volume offered last April. Load factors were up about 1% over the March load factor. It was the seventh consecutive month that load factors have increased—a sharp contrast to the previous 14 months when no gains were realized.**

▶ Vice President Richard Nixon will fly in the first Boeing 707-321 intercontinental jet transport delivered to Pan American World Airways on his July 22 visit to Moscow. Nixon plans to fly nonstop from Friendship International Airport at Baltimore to Moscow, some 5,300 mi. Boeing plans a preliminary shakedown range test of the plane this week on a nonstop flight of some 6,756 mi. from Seattle to Rome. Nixon picked the Pan American jet in preference to a Military Air Transport Service plane.

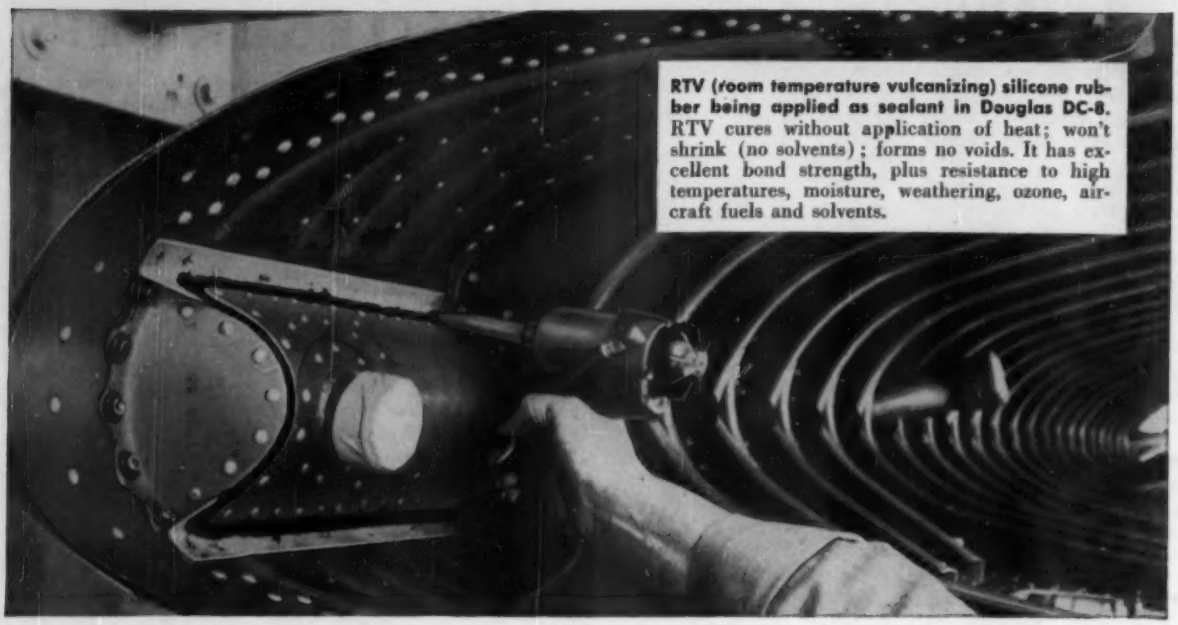
▶ **Prospects that Europair, a plan to pool the equipment, spares and facilities of five European airlines, will survive as a competitive threat to the U. S. carriers are growing dimmer. Withdrawal of KLM from the pooling plan leaves only Air France and Sabena to provide Europair with the strong support it needs to achieve success. Both Lufthansa and Alitalia, remaining members of the five-carrier pool, are showing only a mild interest in the plan.**

▶ German government is expected to appropriate 60 million marks (about $15 million) for the development of two new short-to-medium range turboprop transports during the next six years. One is a 25-to-30 passenger airliner designed by Ernest Heinkel Fahrzeugbau. The other is an 80-seat transport designed by Hamburger Flugzeugbau. Request for funding is now before the German Parliament.

▶ **Rebuilt Schoenefeld Airport serving East Germany's section of Berlin is scheduled to have helicopter taxi service to connect with the city's center. The airport terminal will be equipped with three loading fingers that will enable passengers to board and debark from planes without using conventional loading stairs. These "scaffold bridges" are being built with the aid of Russian engineers and are similar to those planned for Soviet airport terminal buildings.**

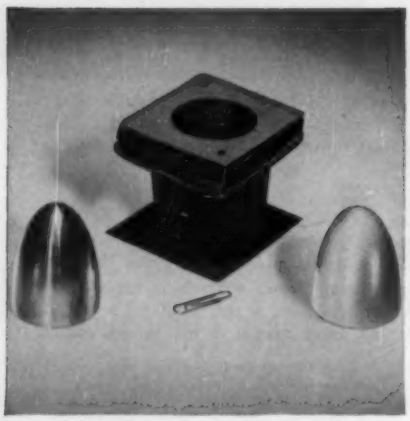
▶ Trans World Airlines last week became the first carrier to sign a Civil Reserve Air Fleet (CRAF) contract with the Air Force. Negotiations on the contracts with the airline industry began at least six years ago. During the period, airlines voluntarily allocated 250 civil aircraft as standby equipment for military logistical purposes in the event of an emergency. Air Force has to complete negotiations with 28 additional air carriers to settle the CRAF program.

▶ **Frontier Airlines President L. B. Maytag has charged that tight regulations of the Civil Aeronautics Board keep efficient management away from the local-service carrier industry. Referring to himself as a "capitalist," Maytag said he was discouraged over his attempts to operate his airline to make money, adding that CAB's ceiling on salaries prevented him from attracting high-level management personnel. He called for less distinction between local service and trunkline operators and for permanent subsidy rates as two ways of coping with local service problems.**



RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.

Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

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GENERAL ELECTRIC

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Aeroflot Il-18 Brings Soviet Delegates to Geneva

Soviet delegates to the Foreign Ministers Conference at Geneva, Switzerland, were flown there in this Il-18 turboprop transport, shown on taxiway at the Geneva Airport. The aircraft, which carries from 70 to 100 passengers, will be used on new routes this summer to the northern Caucasus, Crimea and central Asia (AW May 11, p. 45).

Southwestern Cities Vie for Trunklines

By Russell Hawkes

Los Angeles—Demands of cities throughout the Southwest for trunkline service to Texas, Louisiana and the East Coast were heard by Civil Aeronautics Board here last week as hearings continued in the Southern Transcontinental Service Case which is probably the last of the great domestic route contests due to the filling up of all potential long-haul routes.

Hearings will continue here during the first half of this week and will begin in Miami on June 15.

Airlines competing for the routes will be heard in Washington in July. Local service and regional airlines will also be heard in attempts to protect their routes from duplication by trunkline carriers. Western Air Lines and Continental Airlines will try to persuade the Board that their regional routes should be extended eastward to Dallas-Fort Worth and Houston, and Capital Airlines will attempt to win a route extension west to those cities. Other major carriers will be trying to get transcontinental routes from Florida and Georgia across the southern tier of states to the California cities of San Francisco, Los Angeles and San Diego.

Intercity rivalries played an important part in early testimony here. If cities not now recognized by CAB as terminals can win designation as such, they can expect more rapid growth of airline service, generally, which would bring considerable economic advantages (AW May 11, p. 38).

San Francisco interests are arguing that satisfactory service from there to the Southeast can be provided only by direct, one-carrier service that does not run via Los Angeles. They produced a witness from Lockheed Missile and Space Division on the first day of hearings who testified that such service would help the company support its development activities at Cape Canaveral, Fla.

Under questioning by CAB counsel, the Lockheed spokesman testified that company traffic to Cape Canaveral would not be reduced very much by the transfer of development and research activities to Vandenberg AFB, Calif.

Growing Operation

He said that development of only one weapon has been moved there from Florida and that Lockheed expects its operations at Cape Canaveral to grow somewhat in the future.

He said that recent addition of service to northern Florida from San Francisco by way of St. Louis by Trans World Airlines provides a more flexible schedule but that reduction in time en route is modest.

Nearby Oakland is attempting to show that it is entitled to be a terminus in its own right and that San Francisco International Airport cannot serve the area adequately by itself.

A similar situation is shaping up in southern California where the big suburb of Long Beach is trying to obtain the status of a terminal city. Long Beach interests introduced 20 witnesses during the Los Angeles hearings to demonstrate their point. The difficulties of Los Angeles traffic and the great distances between industrial and economic centers in southern California are used to support their case. A witness from North American Aviation's Downey plant testified that Long Beach Airport can be reached in half the driving time needed to reach Los Angeles International Airport.

In opening the first day's hearings before a crowd of more than 100 interested parties and observers, defenders of Los Angeles International Airport outlined the $100 million development program which the airport is now undergoing. Approximately $59,200,000 has already been spent. A witness from the Los Angeles Airport Authority testified that traffic through the airport has expanded 309% in the past five years.

When the airport development program is completed in 1961, the finger configuration of the terminal will be replaced by the new "satellite" layout. Four parallel runways will provide extremely high handling rates with maximum safety. The witness testified that except for ½% of the time, winds are from the west, eliminating the need for a network of runways on different headings. There will be one north-south runway.

Silicone Products Dept., Waterford, N. Y.

Executive Salaries Detailed by Carriers

Washington—Following is a list of airline officers' and directors' salaries, bonuses and indirect compensation, expenses and stock holdings for the year ending Dec. 31 as reported to the Civil Aeronautics Board:

Trans World Airlines, Inc.—**W. L. Pierson**, chairman of the board of directors and director, $62,466.82 salary and 200 shares of common stock; **C. S. Thomas**, president and director (elected 7/15/58), $27,175.35 salary and no stock; **E. O. Cocke**, senior vice president—sales and director, $33,699.83 salary and 1,100 shares of common stock; **A. V. Leslie**, senior vice president—finance, treasurer and director, $33,699.84 salary and 90 shares of common stock; **F. W. Ayers**, director, $300 salary and no stock; **P. Bradley**, director, $1,100 salary and no stock; **G. H. Clay**, vice president—administrative services and director (resigned 1/31/58), $4,602.76 salary and no stock.

J. A. Collins, director (fees paid in accordance with senior consultant contract during 1958 were $46,165.58), no salary and 1,769 shares of common stock; **N. Dietrich**, director, no salary or stock; **A. B. Eisenhower** (deceased 1/26/58), no salary or stock; **O. Holcombe**, director, $1,300 salary and no stock; **S. Maestre**, director, $1,200 salary and 332 shares of common stock; **M. E. Montrose**, director, $500 salary and no stock; **C. H. Price**, director, $600 salary and no stock; **H. E. Rogers**, director, $800 salary and no stock; **Ben-Fleming Sessel**, director, $1,200 salary and no stock; **A. D. Simpson**, director, $1,400 salary and 334 shares of common stock; **T. A. Slack**, director, $1,400 salary and no stock; **L. Wright**, director, $700 salary and no stock.

F. G. Betts, vice president—purchasing, $21,280.06 salary and no stock; **F. E. Busch**, vice president—operations, $29,864.08 and no stock; **J. H. Clemson**, vice president, $24,110.83 salary and 84 shares of common stock; **P. G. Desautels**, vice president—passenger service, $24,110.83 salary and 254 shares of common stock; **R. M. Dunn**, vice president — overhaul, maintenance and stores, $20,806.43 salary and no stock; **C. S. Fullerton**, vice president and general sales manager, $23,646.57 salary and no stock; **G. L. Gilmore**, vice president—public relations, $19,316.33 and 33 shares of common stock.

C. E. McCollum, vice president—national accounts, $18,664.34 salary and no stock; **R. W. Rummel**, vice president—engineering, $19,258.26 salary and no stock; **T. K. Taylor**, vice president, $23,243.89 salary and 36 shares of common stock; **J. W. Thomas**, vice president—civic affairs, $18,045.16 salary and no stock; **J. D. Harrigan**, vice president— regional sales, $15,642.10 salary and no stock; **J. W. Letzkus**, vice president—regional sales, $19,001.58 salary and 400 shares of common stock; **L. P. Marechal**, vice president—regional sales, $16,880.57 salary and no stock; **R. Mazzarrini**, vice president—regional sales, $16,598.27 salary and no stock; **R. E. Montgomery**, vice president—regional sales, $19,720.34 salary and no stock.

A. L. Stewart, vice president—regional sales (retired 2/28/58), $4,177.03 salary and no stock; **E. W. Barker**, assistant secretary, $13,499.03 salary and no stock; **R. Duckworth**, corporate secretary, $16,439.57 salary and no stock; **W. E. Booker**, assistant treasurer, $16,328.32 salary and no stock.

Following firms and persons were paid for services rendered during 1958: **Abbey Limousine**, limousine service, $9,484.80; **Airport Concessions, Inc.**, services at Los Angeles Ambassador Club, $7,744.19; **Louis R. Barbier**, transporting and setting up advertising, $9,766.18; **Carey Cadillac, Inc.**, limousine service, $29,811.05; **Chadbourne, Parke, Whitside & Wolff**, legal services and resident attorney's fees, $409,592.02; **Cravath, Swain & Moore**, attorney services in connection with loan agreement, $7,500; **Cresap, McCormick & Paget**, management consultants, $83,619.59; **Ebasco Services, Inc.**, acturial services, $5,017.89; **Employers Overload Co.**, clerical services, $16,110.76; **Foote, Cone & Belding**, advertising service charges and commissions, $43,585.53.

Haskins & Sells, audit fees and professional services, $95,975; **Heart of America United Campaign**, annual contribution, $11,250; **Institute of Visual Training, Inc.**, service charge for booking, inspecting and shipping film, $29,977.59; **The Interstate Co.**, services at San Francisco Ambassador Club, $9,141.37; **Irving Trust Co.**, General administration and maintenance of trust securing loan, $16,473.80; **George A. Koteen Associates**, utility rate consultants, $5,559.43; **McNutt, Dudley, & Easterwood**, legal services in connection with Ambassador Club, $7,011.87; **New York Trust Co.**, transfer agency for company stock; $13,294.26.

Stevens Institute of Technology, research services for stores department, $5,033.76; **Ward, Plunkett & Cooney**, legal services for **TWA vs. Castleton, Inc.**, $44,279.51; **Waters, Arditto & Waters**, tax consultants, $6,230; **Wright, Wright, Goldwater & Wright**, legal services, $10,710.27.

Western Air Lines, Inc.—**T. C. Drinkwater**, president and director, $67,900 (includes directors' fees), $7,627 expenses and 6,185 shares of capital stock; **S. R. Shatto**, vice president—operations and director, $40,400 (includes directors' fees), $737 expenses and 3,655 shares of capital stock; **M. W. Landes**, vice president—service, $31,500 salary, $742 expenses and 1,780 shares of capital stock; **P. E. Sullivan**, vice president—administration and secretary (deceased 9/10/58), $21,875 salary, $200 expenses and no stock; **A. F. Kelly**, vice president—sales, $31,500 salary, $3,630 expenses and 2,868 shares of capital stock; **J. J. Taylor**, vice president and treasurer, $31,500 salary, $404 expenses and 2,361 shares of capital stock; **D. P. Renda**, vice president—legal and secretary (elected secretary 10/3/58), $31,500 salary, $3,790 expenses and 1,047 shares of capital stock.

S. Gewirtz, vice president—administration (joined Western in November, 1958), $6,413 salary; $2,505 expenses and no stock; **G. G. Brooder**, vice president, $24,000 salary, $6,921 expenses and 1,343 shares of capital stock; **C. J. J. Cox**, controller and assistant treasurer, $24,000 salary, $732 expenses and 1,286 shares of capital stock; **W. C. Jennings**, assistant secretary, $2,642 salary, $106 expenses and no stock; **J. W. Simpson**, assistant secretary, $2,642 salary, $184 expenses and 10 shares of capital stock; **E. H. Brown**, assistant secretary (until 10/3/58) now director of personnel, $12,086 salary, $197 expenses and no stock.

Following directors were paid directors' fees only: **W. S. Bartman** (did not stand for re-election at meeting of 12/15/58), $300 fee, no expenses or stock; **G. Y. Billard** (did not stand for re-election at meeting of 12/15/58, $300 fee, $937 expenses and no stock; **H. W. Darling**, $400 fee, no expenses and 2,300 shares of capital stock; **R. E. Driscoll, Sr.**, $400 fee, $24 expenses, 600 capital shares and $7,000 principal amount of debt securities; **W. H. Gonyea** (resigned 10/3/58), $200 fee, no expenses or stock; **H. C. Haight**, $500 fee, $26 expenses and 100 shares of capital stock; **G. Lowry**, $100 fee, no expenses and 1,036 shares of capital stock; **Dr. D. H. McLaughlin**, $300 fee, no expenses and 112 shares of capital stock.

L. W. Pogue, $400 fee, $106 expenses and 1,135 shares of capital stock; **D. Swim**, $400 fee, $405 expenses, 4,428 capital shares and $339,000 principal amount of debt securities; **H. J. Volk**, $500 fee, $60 expenses and 104 shares of capital stock; **J. M. Wallace**, $400 fee, $150 expenses and 112 shares of capital stock; **A. Warden**, $500 fee, no expenses and 112 shares of capital stock; **S. F. Woodbury**, $400 fee, $27 expenses and 145 shares of capital stock.

Following firms and persons were paid for services rendered during 1958: **Pogue & Neal**, Legal, $20,360; **Darling, Shattuck & Redmonds**, legal, $37,429; **O'Melveny & Myers**, legal, $42,672; **Pereira & Luckman**, architects, $20,849; **Security—First National Bank of Los Angeles**, transfer agents, $12,611; **Georgeson & Co.**, solicitation of proxies, $5,747; **William E. Simkin**, arbitrator, $5,307.

AAXICO Airlines, Inc.—**H. J. Korth**, president, $104,000 salary and 16,200 shares of common stock; **J. G. Helvey**, vice president, $22,200 salary and no stock; **E. P. Odenwalder**, secretary-treasurer, $10,650 salary and no stock; **O. F. Stern**, vice president—sales, $12,000 salary and no stock; **J. A. Young**, vice president—operations, $10,500 salary and no stock; **W. L. Hanks**, chief pilot, $13,800 salary and no stock. **Coates Lear** was paid $10,648.17 for legal services.

Aerovias Sud Americana, Inc.,—**V. V. Carmichael, Jr.**, president, $15,000 salary, 10,885 common shares and 25 preferred shares of stock; **C. B. Powell**, vice president, $9,000 salary, $3,000 in fees and 6,000 shares of common stock; **W. M. Bussey**, secretary, $3,600 salary and 12,857 shares of common stock; **W. M. Dunn, Jr.**, vice president, $10,920 salary and 600 shares of common stock; **M. K. Williams**, vice president, $9,900 salary and no stock; **J. M. Rodriguez**, treasurer, $10,560 salary and 100 shares of common stock; **F. S. Buchanan**, assistant secretary, $1,388.46 salary, 20,622 common shares and 100 shares of preferred stock; **C. W. Sheppard**, assistant treasurer, $7,800 salary and 150 shares of common stock.

Following directors were not paid a salary; **T. McLean**, no stock; **P. Hawkins**, 3,238 common shares and 500 shares of preferred stock; **L. E. Harmon**, no stock; **M. Carson**, 100 shares of preferred stock; **D. Carter**, no stock; **R. Logan**, no stock; **G. W. Daniels**, no stock. **S. S. Colker & Associates** were paid $8,675.57 for consulting on preparation for certificate hearing; **S. D. Leidesdorf & Co.**, was paid $10,800 for accounting services.

Flying Tiger Line, Inc.—**S. B. Mosher**, chairman of the board, $200 director's fee, 29,150 common shares and 818 shares of preferred stock; **R. W. Prescott**, president and director, $50,000 salary, 5,640 common shares and three shares of preferred stock; **F. Benninger**, vice president-treasurer, $30,000 salary and no stock; **W. E. Bartling**, vice president, $17,500 salary and 305 shares of common stock; **G. T. Cussen**, vice president, $16,667 salary, 110 common shares and 33 shares of preferred stock; **F. B. Lynott**, vice president, $25,000 salary and $10,000 worth of debentures; **N. B. Berboth**, $15,000 salary and no stock; **J. L. Higgins**, vice president, $18,125 salary and no stock; **G. S. Oberdorf**, vice president, $15,000 salary and no stock; **V. F. Zimmerman**, vice president, $15,300 salary and no stock; **O. R. Burghardt**, secretary-assistant treasurer, $18,000 salary and 45 shares of common stock; **R. B. Stump**, assistant secretary, $11,725 salary and no stock; **N. L. Meyers**, assistant secretary and director, no salary, $200 director's fee, 3,363 common shares, eight preferred shares and $85,000 worth of debentures.

Following directors were not paid a salary but received directors' fees: **A. T. Chase**, $200 fee, 102 common shares and $25,000 worth of debentures; **H. Rehrig**, $200 fee and 110 shares of common stock; **J. C. Cosgrove**, $200 fee, 551 common shares and $25,000 worth of debentures; **A. G. Linkletter**, $100 fee and 210 shares of common stock; **C. Luckman**, $200 fee and 1,050 shares of common stock; **J. C. Tyler**, $200 fee, 105 common shares and $5,000 worth of debentures; **R. Axe**, $200 fee, 420 direct common shares and 630 common shares in name of others; **B. Gresov**, $200 fee and 500 common shares in name of others.

The following firms and persons were paid for services rendered during 1958: **Meyers & Batsell**, legal, $61,500; **Arthur Anderson & Co.**, accounting, $19,800; **Hill, Farrer & Burrill**, legal, $34,290; **Coverdale & Colpitts**, consulting engineers, $11,865; **Hixson & Jorgensen**, advertising, $22,586.

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Space Technology Laboratories—Part II:

STL Probes Missile Defense Techniques

By Irving Stone

Inglewood, Calif.—Services that Space Technology Laboratories, Inc., performs for USAF's Ballistic Missiles Division include a variety of special programs in ballistic missiles and related techniques, and in the space field.

This special work, ranging from small specific projects that have just begun to others that might grow into extensive programs, is handled by STL's Special Programs office under William Hebenstreit.

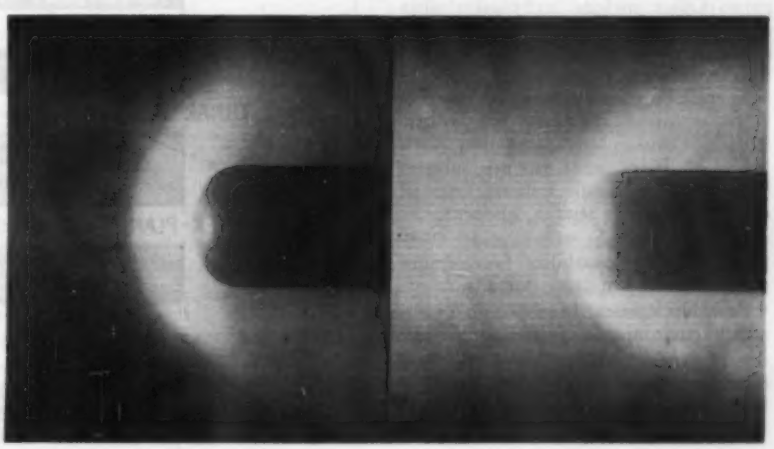
STL's mission in ballistic missile engineering gives it the responsibility to design the missile system so that it will have the highest probability of completing the projected mission. Soon after USAF's intermediate and intercontinental ballistic missile projects got under way, many segments of industry began to investigate anti-ICBM measures, with the result that considerable talent has been assigned to this effort. Soviet Russia also is channeling considerable effort into this area.

Proponents of anti-ICBM measures have claimed with some validity that defense against ballistic missiles may be feasible under certain conditions. This indicates a need to design the missile system with a capability to overcome defensive measures of a potential enemy. STL and others have made studies of defense system penetration aids and techniques that would overcome, degrade, or confuse enemy defense systems.

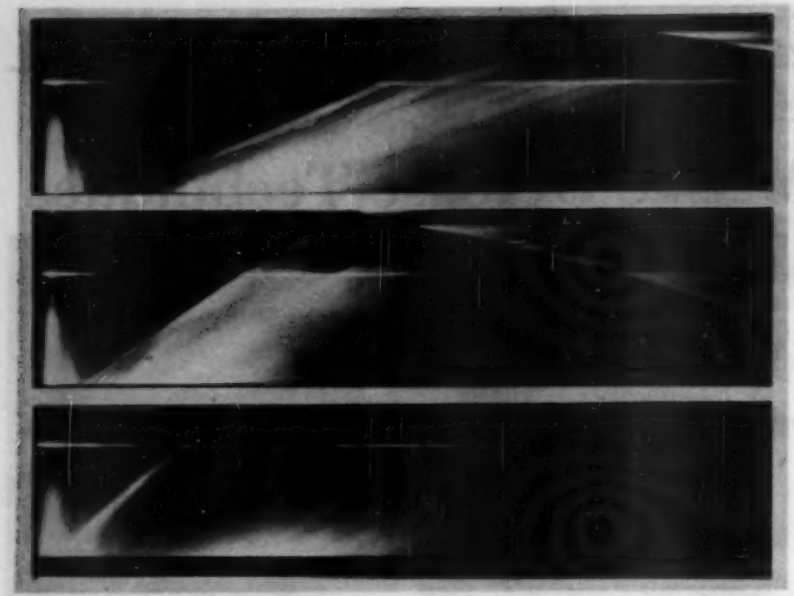
Some time ago, STL surveyed this general problem area, took note of the various studies and isolated techniques being considered and came to the conclusion that there was no specific program to integrate and develop these techniques into the ballistic missile system.

STL formulated a program and presented it to the Air Force, which approved the plan.

STL now is performing systems engineering and technical direction in connection with penetration techniques and devices (strategy plus hardware). About 10 other contractors are involved, and four or five of these already are in the ballistic missile program. Effort is being carried out on two levels —research, development and testing of a number of techniques and devices which could be used in penetration aids, and actual integration of the most



ELECTROMAGNETIC shock tube measures properties of high temperature plasma. Spectrograph (top right) determines impurities and temperature of heavy hydrogen. Below, magnetohydrodynamic shock wave tests are made at flows to Mach 25.



WAVE speed pictures show reflection of white-hot gas produced by a supersonic shock wave in studies to calibrate a shock tube and determine wave characteristics under temperatures ranging from 10,000 to 100,000F. Studies have bearing on space re-entry.

favorable of these into an operation system design.

Specific devices are now under development for test in actual missile flight. This proving will be a compatibility check between interfaces, and an actual evaluation of specific components, such as penetration subsystems. The entire integrated scheme is projected to be checked shortly to provide a proven system for early operational capability.

It appears that there is more than one penetration aids system that could be used. Under investigation are advanced techniques on which a decision is yet to be made. Some involve basic phenomena studies carried out on a research level, and expected to lead to new devices which probably will be applied to advanced weapon systems.

Other activities of the Special Programs Office include technical studies in support of space programs under consideration by Ballistic Missile Division's space group.

Special Programs Office also has provided technical assistance to Ballistic Missile Division in connection with types of bases and ground support equipment for missile systems. Over-all objective of these studies, aimed to assure that the U.S. will have an effective retaliatory capability for a minimum dollar expenditure, include:

- **Base development to survive** in a post-attack environment, including hardening of bases, isolation of missile and equipment from ground shock.
- **Dispersion of bases.**
- **Trade-off studies between** hardness and amount of dispersion of the elements of the bases, such as the launchers, communication, control centers.

Program Staff

Special Programs employs about 18 key technical people—physicists, mathematicians and electrical engineers. About seven of these have doctorates. There also are teams of consultants, top authorities in their respective fields, who are selected by Ballistic Missile Division.

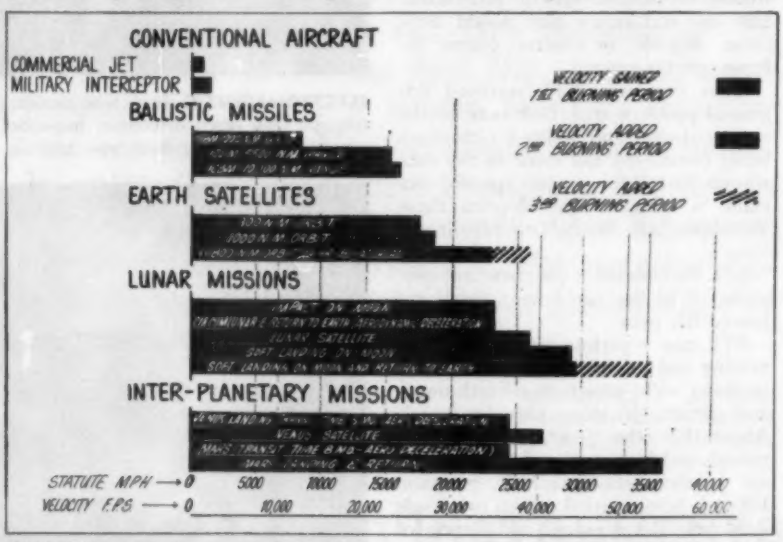
STL's Physical Research Laboratory takes a deep look into scientific possibilities of the near and far future. Director is Dr. Milton U. Clauser, a scientist and an STL vice-president.

Clauser favors probing the dim areas of technology that lie ahead. In 1954, scientists did not believe it would be possible to bring a re-entry body through the atmosphere. Re-entry vehicle, they believed, was going to be the stumbling block of the ballistic missile program. Some also felt that attainment of required guidance accuracy would be another hurdle that would not be overcome.

Shock tubes with which to study the physics of re-entry could have been built four years earlier than 1954 if the long-range scientific problems had been foreseen, Clauser feels. Similar situations exist today in other areas, and will always exist, he insists. STL's look into the future is a speculation that involves spending money and manpower, he admits. But the Physical Research Laboratory's scientific personnel see work to be done in these areas:

- **Magnetohydrodynamics.** The hottest chemical flame anyone has as yet achieved is about 10,000F. During re-entry conditions, temperatures of approximately 15,000F have been encountered. This raises the question of whether 15,000F is a ceiling or whether this can be multiplied by two, four, 10 or even 100.

If re-entry conditions had introduced a 30,000F temperature, which could not be obtained in a shock tube, the question of how to obtain background data in the laboratory would inevitably have arisen. "Magnetohydrodynamics unhinges us from all limitations which have held us to the 15,000F category," Clauser says. With magnetohydrodynamics, a temperature of 100 million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BALLISTIC MISSILES
EARTH SATELLITES
LUNAR MISSIONS
INTER-PLANETARY MISSIONS
VELOCITY GAINED 1ST BURNING PERIOD
VELOCITY ADDED 2ND BURNING PERIOD
VELOCITY ADDED 3RD BURNING PERIOD
STATUTE M.P.H. → 0 5000 10000 15000 20000 25000 30000 35000 40000
VELOCITY F.P.S. → 0 10,000 20,000 30,000 40,000 50,000 60,000

SPEED-BAR chart shows equivalent velocity values required for various missions, as calculated by technicians of Space Technology Laboratories, Inc., Astrovehicles Laboratory. Speed values are projected up to 40,000 mph.

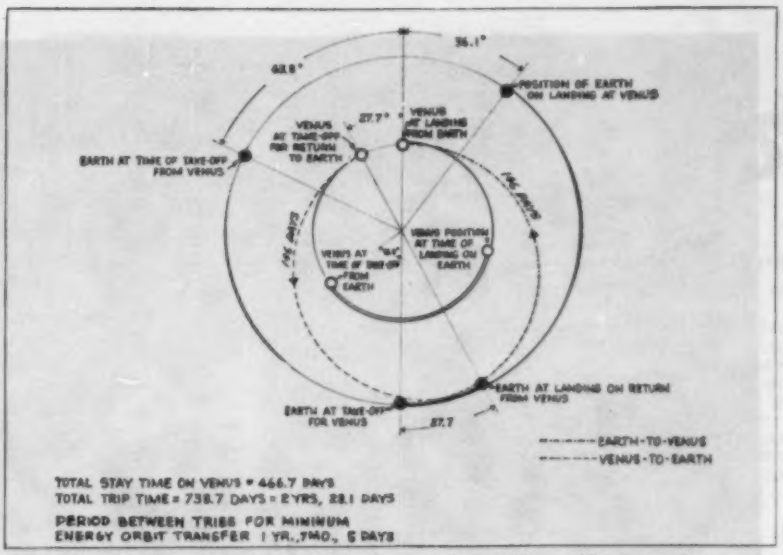
degrees might be obtained—and this is the objective, Clauser declares.

It appears reasonable that more than one million degrees already has been attained with the pinch effect, although this temperature value is difficult to measure. But it is certain, Clauser says, that with magnetohydrodynamics an electric shock tube can be devised that will give temperatures of at least hundreds of thousands of degrees, and that this tube can be transferred into a plasma propulsion device (not the arc jet type) for attainment of very high specific impulses from 3,000 to 10,000 sec. (equivalent to 10,000 times 32, or 320,000 fps. exhaust velocity). STL's Physical Research Laboratory is working on this propulsion problem and has built a shock tube for testing up to Mach 40 with air as the working medium, and up to Mach 140 using hydrogen.

Magnetic Fields

It also is working on ways to use magnetic fields to control flow around bodies during re-entry. This control might be used to reduce heat transfer, and to divert the free stream to produce a pitching moment that would slew the body for directional guidance. This work still comprises rather fundamental analyses that will be immediate forerunners to engineering studies involving weights, sizes, powers, etc.

• **Controlled fusion reaction.** One prime reason for interest in this phenomena is its possibilities for propulsion, in view of the light weight of the reaction product, helium. To obtain the fusion reaction, the heavy hydrogen has to be heated to a temperature of the order of 100 million degrees. Only conceivable way to hold the hydrogen together long enough at this temperature is the use of the magnetic bottle—a magnetic field wrapped around a hot plasma.


POSITION OF EARTH ON LANDING AT VENUS
VENUS AT LANDING FROM EARTH
VENUS AT TAKE-OFF FOR RETURN TO EARTH
EARTH AT TIME OF TAKE-OFF FROM VENUS
VENUS POSITION AT TIME OF LANDING ON EARTH
EARTH AT LANDING ON RETURN FROM VENUS
EARTH AT TAKE-OFF FOR VENUS
EARTH-TO-VENUS
VENUS-TO-EARTH
TOTAL STAY TIME ON VENUS = 466.7 DAYS
TOTAL TRIP TIME = 738.7 DAYS = 2 YRS, 28.1 DAYS
PERIOD BETWEEN TRIPS FOR MINIMUM ENERGY ORBIT TRANSFER 1 YR., 7 MO., 5 DAYS

GRAPIC representation of a round trip between earth and Venus. Total stay time on the planet Venus would be 466.7 days before return to earth.

No clear path has been found yet to establish feasibility and control of thermonuclear reaction. But in "every decade we seem to make twice the progress we made in the previous 10 years, and if you can visualize what you want to do, you ought to be able to do it in 10 years," Clauser said. "If you haven't done it in that time, you can chalk it up as being impossible."

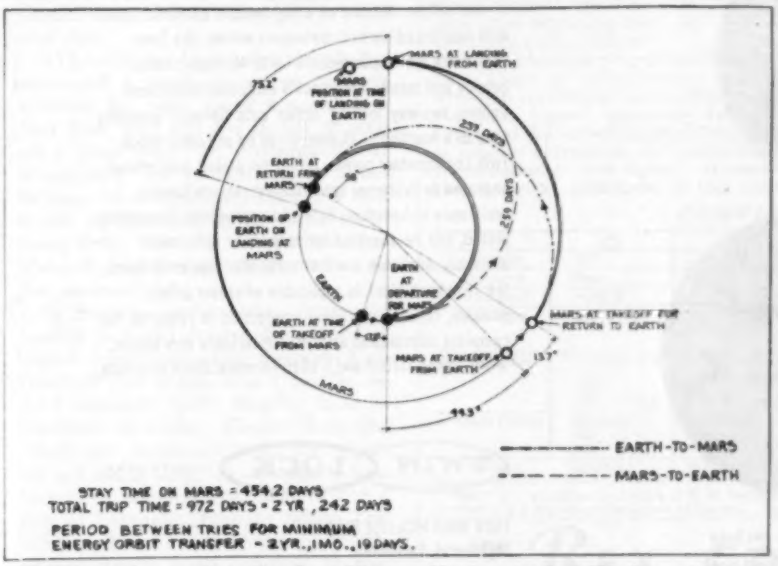
If some of the high-density devices prove feasible and reactors of reasonable size can be created—with dimensions of a few feet, perhaps five, 10 or 20 ft. instead of 100 or 500 ft.—then propulsion potentialities would become very interesting, and the possibility of interplanetary travel would take on a new complexion. There may be some space achievements which could not possibly be done otherwise.

A manned landing on Mars and return to earth would require a fantastically large rocket ship if it were propelled by chemical means—perhaps starting with hundreds of millions of pounds of prime movers and equipment. The craft probably would include an ion propulsion device, whose low thrust output could not do the job of taking off and landing but could be used in orbit transfers. If sufficient effort is applied, there is hope that controlled fusion might bring initial weights down to a more feasible value for propulsion throughout the cycle, from takeoff to final landing.

STL's Physical Research Laboratory has conducted extensive theoretical and experimental work on controlled fusion. First problem is to heat the heavy hydrogen (deuterium) to about 100 million degrees. Then it must be contained for at least four milliseconds (according to formula where pressure in atmospheres multiplied by time in seconds is equivalent to approximately four for one particular reaction).

This means that for the relatively high density devices, where pressures are about 1,000 atmospheres, the hot plasma will have to be held for about four milliseconds to have output equal input. "After this period of time, you begin to get a bonus," Clauser said.

The problem of converting reaction power to useful power is so difficult that


MARS AT LANDING FROM EARTH
MARS POSITION AT TIME OF LANDING ON EARTH
EARTH AT RETURN FROM MARS
POSITION OF EARTH ON LANDING AT MARS
EARTH AT DEPARTURE FOR MARS
EARTH AT TIME OF TAKEOFF FROM MARS
MARS AT TAKEOFF FROM EARTH
MARS AT TAKEOFF FOR RETURN TO EARTH
EARTH
MARS
259 DAYS
259 DAYS
EARTH-TO-MARS
MARS-TO-EARTH
STAY TIME ON MARS = 454.2 DAYS
TOTAL TRIP TIME = 972 DAYS = 2 YR, 242 DAYS
PERIOD BETWEEN TRIPS FOR MINIMUM ENERGY ORBIT TRANSFER = 2 YR., 1 MO., 19 DAYS.

ROUND TRIP from earth to the planet Mars would take a total of 972 days, with a stay time on Mars of 454.2 days, as calculated by Astrovehicles Laboratory.

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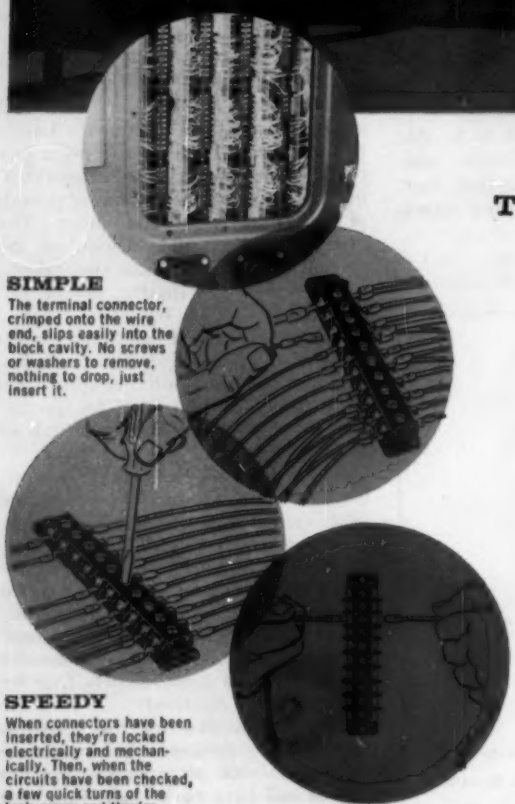

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almost all researchers are concerned only with the heating and containment of the plasma. STL's attention is now being given to these phases.

With respect to heating, STL is working on the concept of the super-fast pinch—the magnetic squeeze that compresses the gas so quickly that it literally sweeps the molecules up to velocity corresponding to a temperature of 100 million degrees (equivalent to a velocity of about 3 million fps., or 1/300 the speed of light). The laboratory has built the experimental apparatus to test the theory of the super-fast pinch. Researchers have encountered and overcome a number of serious difficulties, but it is too early to say whether the approach will prove feasible, according to Clauser.

Radio Waves

On the problem of containment, laboratory scientists have some unusual ideas on using radio frequency waves in a hollow metal cylinder to stabilize the interface between the magnetic field and the plasma. Experiments relating to these concepts are just beginning.

Super-conductivity. This is another field of theoretical and experimental research which STL's Physical Research Laboratory is probing. Phenomenon of super-conductivity was discovered at least 50 years ago. If any one of a number of metals, including lead and tin, is cooled to within 0 to 20R, its electrical resistance disappears. Thus, if electrical current is introduced into a lead ring at this temperature range, a magnetic field is established and remains undiminished indefinitely, even though no more power is applied.

Clauser believes this phenomenon should be capable of being put to practical use.

STL's Eugene Crittenden already has developed a super-conducting memory element for high speed computers—a thin film, lead and tin circuit printed on a glass sheet. It is maintained at temperature by immersion in liquid helium. Most significant feature is that it has an operating speed about 1,000 times faster than the conventional ferrite core, which reacts to about one to five microseconds.

Within one or two years, it may be feasible to begin design of a computer with a super-conducting memory. Calculations that would take a year to do on a computer could then be done in one-third of a day, Clauser forecasts. There are numerous problems which are not being done on computers now because it is not economical to use a year of computer time to obtain one solution. The STL development, if successful, would make solution of this type of problem feasible. System design problems could be more highly refined

CABLE and WIRE LEADS

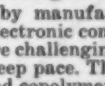
By HOWARD E. PENDERGAST

Technical Director, Rex Corporation

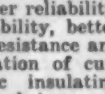
Comparative Properties of Insulating Plastics

Technological advances by manufacturers of electrical and electronic components and equipment are challenging the plastics industry to keep pace. The need for new polymers and copolymers that meet more critical performance requirements is constantly growing. Demands include increased operating temperature range, greater reliability, improved aging and stability, better chemical and radiation resistance and many others. An evaluation of currently available plastic insulating media reveals the progress being made to meet demands.

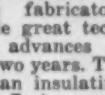
Polyethylene is the logical starting point for a comparative study of plastic insulating. It is one of the most commonly used. Here, the basic carbon-hydrogen molecule is in virtually perfect balance. Polymerization is accomplished by breaking the double bond and connecting a large number of identical molecules. Because of its electrical balance, this polymer is excellent for high-frequency applications. Greater use of polyethylene however, is restricted by its physical properties: relatively low operating temperature and abrasion resistance. These shortcomings have been overcome to some extent by the introduction of "linear" polyethylene with its more controlled orientation of the three-dimensional network.



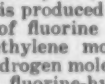
Polyvinylchloride (PVC) is a modification of the polyethylene structure with one chlorine atom replacing one hydrogen atom. This results in physical properties that surpass those of polyethylene: greater abrasion resistance, better dimensional stability, higher operating temperatures and decreased flammability. PVC is readily extrudable by conventional thermoplastic techniques. However, the electrical unbalance of this molecule precludes the use of PVC at elevated frequencies.



Monochlorotrifluoroethylene, more commonly known as Kel-F*, is a modification of PVC with fluorine replacing hydrogen. This substitution, though difficult to achieve, pays off in still-further improved physical properties. Fluorocarbons are more difficult to process than PVC and other carbon-hydrogen linkages. But both the resin manufacturers and the insulation fabricators have made great technological advances in the past two years. The result is an insulating medium offering excellent physical, thermal and chemical properties.



Tetrafluoroethylene, best known as Teflon**, is produced by the total substitution of fluorine for hydrogen in the polyethylene molecule. Like the carbon-hydrogen molecule in polyethylene, this fluorine-hydrogen molecule is in excellent electrical balance and, therefore, is well suited for high frequency applications.



Excelling other commercially available thermoplastics in chemical inertness and operating temperature range, it has singularly provided access to the solution of many different design problems.

Nylon is a readily extrudable complex polymer of nitrogen, carbon and oxygen. Its electrical unbalance and tendency to absorb moisture limit its use as a dielectric or insulating material. However, it is often used in the wire and cable field as a jacket over polyethylene and PVC to increase temperature stability and abrasion resistance.

Which insulation should you specify? Rex Corporation engineers will be glad to help you make the right selection. For an early get-together or technical data for your own evaluation, write today.

COMPARATIVE CHART

	PE	PVC	Kel-F	Teflon	Nylon
Density	.92	1.25-1.45	2.1	2.1	1 .4
Abrasion	Poor	Good	Good	Poor	Excellent
Cold Bend	−70°C	−10°C to −70°C	Below 100°C	−90°C	−55°C
High Temp.	100°C	60°C to 105°C	150°C	200°C	105°C (Heat Stabilized Grade.)
Dielectric Const	60 cycles 2.3 103 106 109 2.3	Depends on Compound	 2.27 2.38	2.0 2.0 2.0 2.0	5.3 — 3.5 —
Power Factor	60 cycles 103 106	Depends on Compound	 .0082	.003 .003 .003	.06 .05 .03
Stiffness	Flexible	Unlimited	Flexible lb/sq. in. 250 x 10³	Flexible lb/sq. in. 50,000-90,000	Flexible To Very Hard

*Kel-F is a registered trademark of M. W. Kellogg Co.
**Teflon is a registered trademark of Dupont.

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to give a higher degree of optimization, Clauser believes.

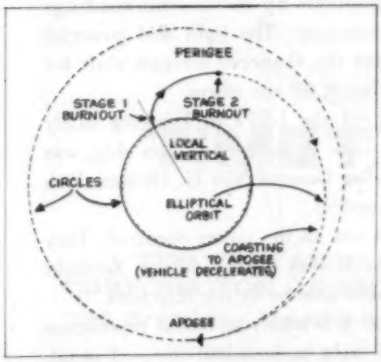
Another promising area of research is the field of super-fluidity—for example cooling liquid helium to a value such that it flows very freely. STL's Physical Research Laboratory hasn't tackled this research area yet, but Clauser thinks that some laboratory should "begin investigation of this subject now."

The laboratory began its theoretical work late in 1955 and got its first lathe in 1956, which was the beginning of experimental work. Technical staff numbers about 20, almost all of whom hold doctorates, some in physics and some in engineering. Also on the staff are about 10 mechanics and technicians.

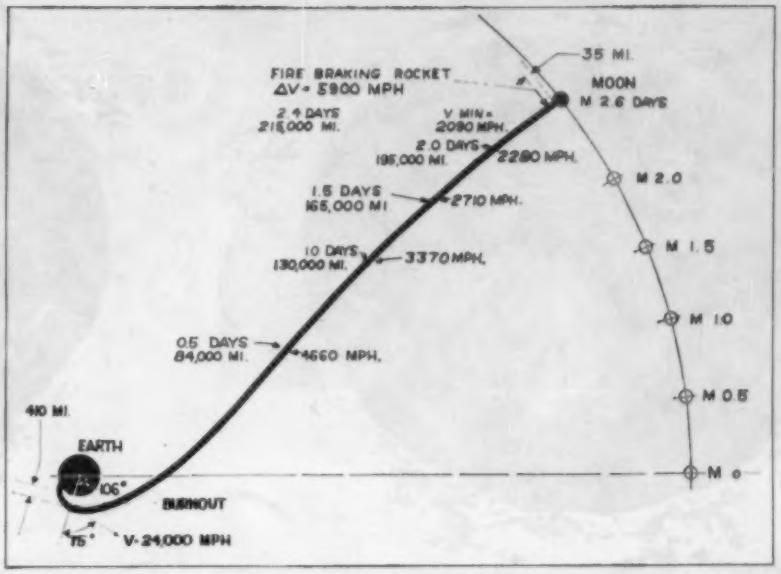
Astrovehicles Laboratory

One of the prime contributions of STL's Astrovehicles Laboratory is technical support for USAF's ballistic missile effort. This STL function essentially is concerned with making decisions. An example is the solution of an interface problem between two components of the system, such as an engine whose thrust has fallen below the 3% thrust tolerance, and the vehicle guidance. Question arises concerning which component to modify, keeping in mind the technical difficulties involved with respect to time schedules, money, production facilities, etc. Resolution of the problem becomes essentially one of compromise. This same type of solution sometimes is required even when a compoent exceeds specification requirements. Hypothetical example of such a case might be when engine fuel rate calibration exceeds specified values. Solution might then resolve itself to determination of whether a propellant utilization system still is required even though it was included in the original design.

Another function of the Astrovehicles Laboratory is to provide technical assistance to contractors in areas where unanticipated technical difficulties are encountered. Unusual qualification of STL in this field stems from knowledge developed in its role of providing integrated systems engineering and technical direction for Air Force's various ballistic missile projects. One instance where this assistance was employed was the establishment of parameters in design of early re-entry bodies. For this work, STL had a concentration of talent because it had been delegated the job by Ballistic Missile Division at a time when it has to be done on company funds, and it is likely that a contractor normally will direct efforts to work on which there is a fairly immediate prospect of a request for proposal from a military or civilian agency.



ASTROVEHICLES Laboratory study shows the general plan for establishing a circular orbit for satellites; third stage rocket is fired at apogee.



COMPILATION of trajectory and speed values for a soft landing on the moon is a typical example of long-range work done by Space Technology Laboratories' Astrovehicles Lab.

At least for the next five years, Astrovehicles Laboratory scientists point out, ballistic missiles probably will be the main first and second stage boosters for space missions. Specialized upper stages, designed for the specific mission, will be used. The laboratory constantly is examining the potential of the military boosters now being produced and is making "paper" designs of matching upper stages. Also involved in these studies are guidance system evaluations for particular missions, attitude control, communications, aspects, etc. STL's studies of Atlas, Titan, Thor and the projected Minuteman to see what missions can be performed, using new designs or modified existing hardware as upper stages, become a catalog of capability. For a specific mission, the compilation shows which combination of vehicles will do the job, and what new equipment will be required, together with a development timetable, payload capabilities and optimum launch periods, even down to time in seconds on the day of launching.

This catalog of possible missions might include analyses of orbiting the moon and the planets Venus and Mars, as well as aspects of landing payloads on these bodies.

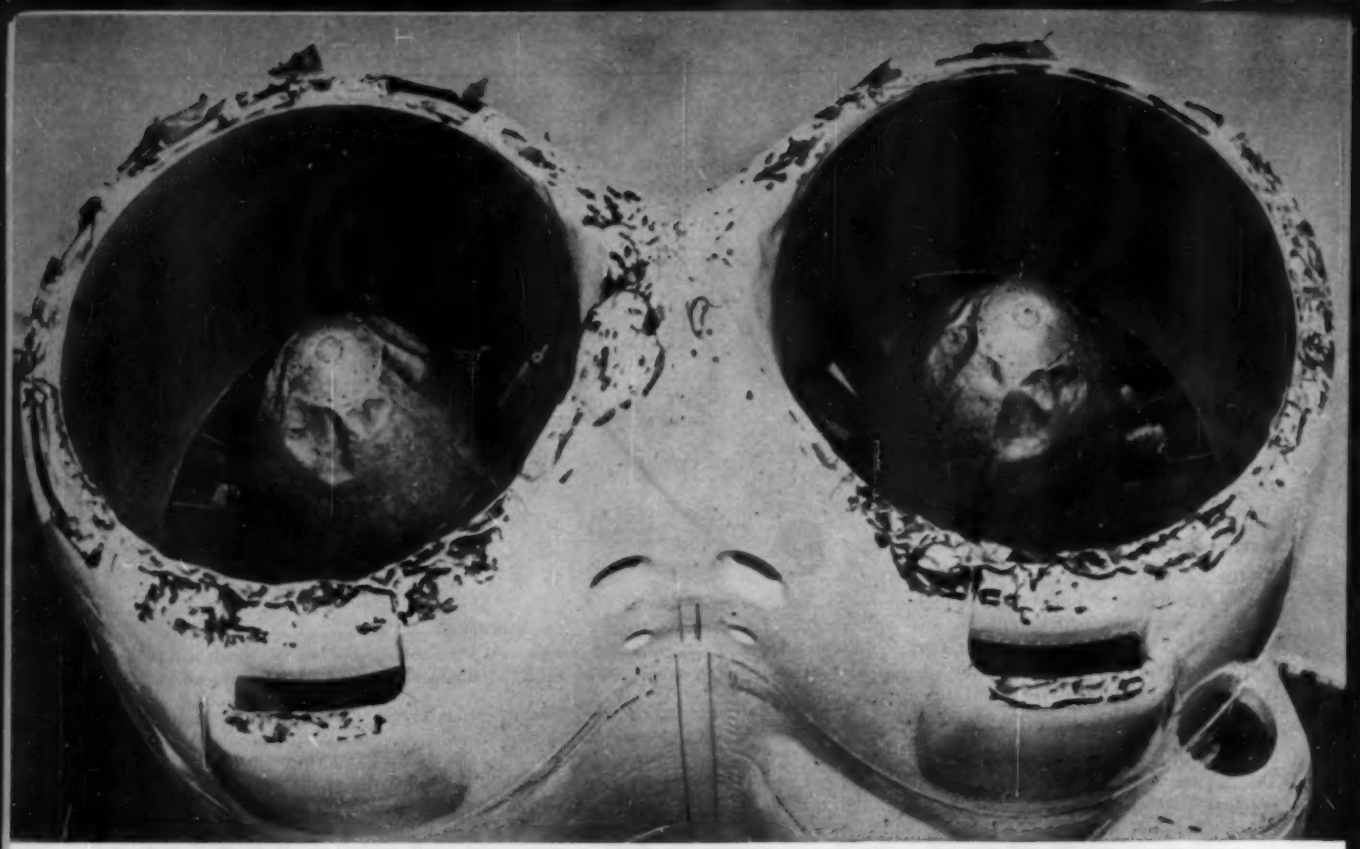
Planetary Re-Entry

Astrovehicles Laboratory also has looked at the re-entry problem with respect to other planets. This is similar to earth re-entry, but would involve design of vehicles keyed to different atmopsheric, surface, and gravitational characteristics. Success of these missions generally would be dependent on very light, accurate and simple guidance developments, adequate communications equipment, attitude control devices for solar cells, antennas and cameras, and propulsion system pointing for mid-course correction. STL draws on its background in ballistic missile technology to make these studies more relatively fast.

Prime example of STL's work in future areas is the effort made with Ballistic Missile Division to compile the first long range man-in-space program for the Air Force. Study went well beyond establishing man in orbit and bringing him back. All Air Research and Development Command centers and the USAF School of Aviation Medicine contributed to this study. STL fed in specialized information and an STL-BMD team integrated the entire plan for a feasible system.

Other typical activities of the laboratory include:

• **Analysis of critical problems** that will arise when systems operate in a space



J-57 Titanium engines save nine-man crew in their $8-million B-52

At 8,000 feet, the B-52 ran into a small and very violent frontal area. Suddenly the airplane was pelted with hailstones the size of baseballs. Flying at 400 miles an hour the damage to the B-52 was terrific.

The windshield smashed. The radome was torn away. The radar antenna was demolished. Wing edges were hammered flat. Holes were punched in the wings and engine nacelles. Flying metal was sucked into the engines and disappeared. Some of the electrical system failed and most of the instruments were out. The aircraft went momentarily out of control.

Major W. F. Zerdecki, the air commander, struggled with the controls. Captain Charles L. Borgeson, Jr., the instructor pilot, sent out the distress call. The crew prepared to bail out.

By this time, the shuddering aircraft had already bucked through the storm. The eight Pratt and Whitney titanium version J-57 engines were still giving full power. Major Zerdecki climbed the B-52 to 23,000 feet where he rendezvoused with a KC-135 tanker. The B-52 crew tested their controls by instrument readings relayed by the tanker crew. The light and powerful titanium engines kept the shattered aircraft aloft for almost two hours after it hit the storm.

The performance of the J-57's in bringing safely home the nine-man crew in their $8-million ship, was described by Brigadier General Nils H. Ohman, 19th Air Division Commander:

"The engines put out all the power required. They performed perfectly. If they hadn't, Major Zerdecki would never have been able to fly the ship back."

Carl Cooper, Pratt & Whitney technical representative, reported: "All eight engines had ingested metal. Magnesium cowling pieces shattered as they went

through the engine. Six of the engines were found to have bits of cowling metal one-eighth of an inch long at the end of the high compressor assembly and pieces of magnesium approximately the same length were found stuck to the first stage turbine blades. The J-57 engines, though slightly damaged, were still serviceable and satisfactory for continued, limited, safe operation. The damage was repairable with a minimum of time and effort."

Since 1954, some 5000 titanium engines have been put into service containing material supplied by Titanium Metals Corporation of America. More than 500,000 hours service time have been accumulated with no reports of failure of the titanium parts.

GREAT STRENGTHS...The strengths of titanium, coupled with its light weight (density 0.16 pounds per cubic inch), have meant valuable fuel economies and increased payloads. At the same time, the excellent corrosion resistance of titanium has reduced costly maintenance and parts replacement.

Steadily declining prices; advances in machining, welding and heat-treating techniques; and development of new alloys have combined to maintain titanium's role as an important engineering metal in the new engines now in design or advanced development.

These same advantages also make titanium metal an economical material of construction for the dead-weight area known as airframe. For example, heat-treated titanium forgings can cut structural weights almost in half.

Titanium Metals Corporation of America has dedicated its full resources to development and production of high-strength aircraft quality material and the technical assistance required to make design potentialities of the metal production realities.

This effort to build an industry has provided TMCA with a wealth of information that is yours when you specify Timet® titanium.

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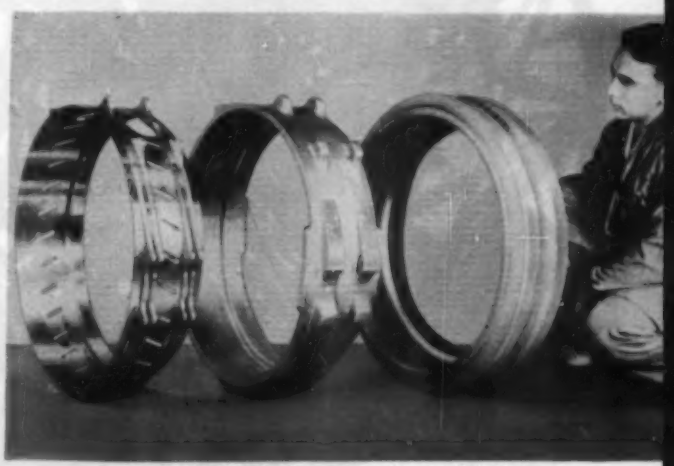
J-57 ROTOR ASSEMBLY, with wheels, blades and spacers forged and machined from TMCA titanium alloy Ti-6Al-4V. Now *new* alloys, such as Ti-7Al-4Mo —already in commercial production—extend useful temperature range and meet higher creep strengths required for engines in design or advanced development stage.

THIS INTERMEDIATE COMPRESSOR CASE ASSEMBLY is used in fighter versions of J-57 engine. Fabrication techniques include ring-rolling, welding, machining, stretch-forming, and piercing. Use of titanium saves 443 pounds per compressor.



STATOR HOUSING of titanium alloy Ti-5Al-2.5Sn, shown here in various stages of fabrication from rolled and welded ring to finish-machined part, provides important weight savings to J-57 engine.

EAR TO SPACE

Constant contact with space vehicles requires extremely sensitive radio tracking stations—sensitive enough to reach out half a million miles and beyond.

Collins Radio Company, working with the National Aeronautics and Space Administration's Jet Propulsion Laboratory, supplied the complete down-range Puerto Rican tracking station and most of the equipment for the Goldstone Lake tracking facility used to maintain successful contact with the National Aeronautics and Space Administration's first Lunar Probe. Collins also participated with JPL in providing one of the SphereDop tracking stations which kept tab on Pioneer IV. The Goldstone tracking station tracked Pioneer IV for 83 hours out to a distance of 407,000 miles.

For more than a decade, Collins scientists and engineers have been exploring radio problems associated with the upper reaches of the atmosphere and space beyond. The company has maintained an active radio astronomy observatory since 1946, and was the first in continuously tracking the moon and sun through the development of highly precise receiving equipment.

Collins Radio Company rapidly is expanding its research in space studies, including space navigation, radiowave propagation, payload instrumentation and electronic systems for space vehicles.

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environment over long periods of time. Propulsion study might include factors such as mid-course guidance correction, terminal-guidance correction, attitude stability systems, and auxiliary power supplies.

• **Re-entry vehicle design** for specific missions. An ICBM-type nose cone is not the most suitable for bringing a man back from orbit, and acceleration has to be limited. Also involved are material problems, re-entry dynamics to ensure stability and avoid porpoising. Another factor is separation of the re-entry vehicle without "nudging it," to avoid trajectory errors. Predictions of effects of winds and atmospheric conditions on impact point is another consideration.

• **Trajectories studies.** These constitute a major category. Optimum trajectories are found first, but depending on guidance system and mission, compromises will be required. An all-inertial system might permit flying an optimum trajectory, but this might require a heavier, less accurate re-entry vehicle so that final choice will be a less-than-optimum trajectory.

• **Engineering mechanics.** This activity performs the structural analysis (in conjunction with the contractor later, if the project is implemented). Dynamic analysis and vibration modes to be anticipated for the vehicle also are worked out. This has a major effect on the design of the control system.

• **Report on potential** of nuclear-powered launching vehicles (boosters). This study has been prepared by Astrovehicles Laboratory without solving the fundamental problem of building the vehicle and without resolution of the feasibility of the nuclear engine. STL used Atomic Energy Commission Los Alamos Laboratory's theoretical data—weight of nuclear engine, thrust, specific impulse, and fuel—and determined booster systems for various missions. Results were compared with chemical systems for the same mission. Reaction temperatures then were varied up and down and additional comparison made with chemical systems. With this approach, STL was able to establish lower limits of the performance of a nuclear system on the basis of competing with chemical systems, providing a target for the nuclear scientists to shoot at. This effort was performed for the Defense Department's Military Liaison Committee to AEC.

In addition to booster aspects the study included schedules, guidance, ground support equipment, test and launch facilities, propellant production facilities—an analysis of the complete package.

• **In addition to purely** analytical studies, the laboratory conducts small-scale laboratory work in areas where feasibility of new developments can be demonstrated or where fundamental understanding of physical phenomena is poor. For example, chemical equilibrium in a rocket nozzle has a strong bearing on the design and efficiency of the nozzle. The laboratory now is engaged in chemical shock tube work for determining equilibrium at temperatures up to 7,000F, and for a pressure range of 600 psi. down to 1 psi. This effort requires special talent with shock tube experience, and personnel were hired when this research was anticipated.

Laboratory efforts also include investigation of material properties and hypersonic aerodynamic problems, using arc-driven tunnels. This work is conducted in small-scale facilities that do not compete with larger industry facilities.

Astrovehicles Laboratory has about 250 technical staff members. Approximately 15 to 20% of them are PhDs.

(This is the second of three articles on Space Technology Laboratories, Inc. The first appeared in AVIATION WEEK on May 18, p. 54.)

Flight Surgeons Urge Extensive Biomedical Space Survival Studies

Los Angeles—Man's knowledge of space biomedicine must be extended much beyond its present scope before flight surgeons will underwrite a space traveler's chances of survival.

Winding up the three day session of the Aerospace Medical Assn. here, Brig. Gen. Don Flickinger, USAF Air Research and Development Command's Assistant for Bioastronautics said, "There has yet to be devised a mechanical substitute for living tissue to function as a testbed for the componentry which is designed to protect and support man in his orbital flight."

Summing up what has been learned through the flight of animals into space, Gen. Flickinger implied that too little emphasis had been placed on the biological aspects of space travel. He recounted six reports, three Russian and three American, which covered work done from 1949 to the present.

First two Russian reports dealt with efforts toward sending dogs aloft in sounding type rockets for short periods of weightlessness. The third Russian report dealt with the orbital flight of the Russian dog Laika. First two American reports were results of the flight of white mice, and the last dealt with the joint Army-Navy Bioflight Project No. 1 "Gordo" in which a South American squirrel monkey was sent aloft in a Jupiter nose cone.

Greater Knowledge

Since animals can neither make up for system deficiencies nor act as a built-in multi-channel tape recorder, Flickinger continued, "We could say that sub-human biological research into the dynamic aspects of space flight requires greater knowledge and care in design of equipment and methods than if a human subject were used.

"The new knowledge contained in space is there to be gained, and it will come to those in fullest measure who apply their energies and resources in the most effective manner. Newsworthy or 'prestige first' experiments without a suitable return of valid and useful biomedical data would truly seem inadequate compensation for the effort, time and money involved," he added.

Military implications of manned space vehicles fall into four categories; scientific, medical, military, and economic, according to Col. Charles H. Roadman, of USAF Headquarters. He said that the four categories are inseparable and efforts toward any one aspect affects the other three.

Space, he continued, offers a new era of military applications, but man should go only if he can improve the mission.

Data Deficiency

As to when a manned military space vehicle would be feasible, Col. Roadman said that after 10 years the U.S. still is "horribly deficient" in technical data necessary to accomplish a successful mission and that "space glamour" is hindering research effort.

One approach to solving man's biological needs during prolonged space travel would be to design the capsule so that its components would have double and triple functions, it was re-

Splinter Faction

Splinter faction, formed in a closed session at the Aerospace Medical Assn. meeting, is composed of flight surgeons disappointed at the apparent over-emphasis on space medicine.

A spokesman for the faction, to be called the Aviation Specialists Group, told Aviation Week the surgeons would devote themselves to the less glamorous, more mundane aspects of everyday, "nuts and bolts" type of aviation medicine. Composed of "99% working flight surgeons," the group will concentrate on problems associated with the physiology of flight in high performance military and commercial as well as private aircraft.

ported. Dr. Douglas Worf, of National Aeronautics and Space Administration, said that beyond a period of four weeks, man cannot carry his own environment and must recycle food, water and air. After six months continuous space travel, photosynthetic processes must be used. One solution, said Dr. Worf, was to make parts of the man's environment, such as shielding, of edible material. Specifically, portions of the vehicle not used for reentry could be designed to be expended during orbit.

Possibility of reducing tolerance to g force following prolonged periods of weightlessness was revealed by Lt. Col. S. C. White, USAF, of the Project Mercury Space Task Group. He said that this problem has not been solved and that it appears particularly difficult since prolonged weightlessness is impossible to produce except during actual orbit.

Solution to long, boring periods of inactivity during travel to other planets may rest in inducing man to hibernate, according to Dr. R. J. Hock of the Arctic Aeromedical Laboratory, Ladd AFB, Alaska. Studies of the Alaskan black bear show that during hibernation the bear's body temperature is lowered approximately 9F. At this temperature, metabolic rate is about 50 to 60% of normal. Dr. Bock assumes that aging occurs at only about half the normal rate during hibernation, due to a lower metabolic rate.

Surgeons have been using hypothermic anesthesia, a form of brief hibernation, during which body temperature is lowered to approximately 86F. Lowering body temperature below this point is not feasible due to the onset of ventricular fibrilation.

Significance of the hibernation theory would be that aging processes of the body would slow down, psychological difficulties of prolonged boredom would be eliminated, and considerably less food and oxygen would be required for a space passenger during this inactive state.

Many problems must be solved before hibernation is practical, however, such as preventing ventricular fibrilation and periodically arousing the space traveler so that energy levels could be built up, the group was told.

Another hazard of weightlessness was described by Dr. H. J. von Beckh of the Aeromedical Field Laboratory, Holloman AFB, N.M. To determine the reactions of a subject who suddenly found himself in a weightless condition, a volunteer was kept awake for 48 hr. He was then taken aloft in a Lockheed F-94C and after disconnecting his headset and lowering a helmet visor, fell asleep. The aircraft was then carefully maneuvered into a ballistic trajectory and the subject awakened by a tug on a string fastened to his wrist.

The subject's reaction was described by Dr. von Beckh as follows: "His first impression upon awakening was that his arms and legs were floating away from him, so that he felt a desperate need to pull them back toward his body to maintain some sort of normal posture. He tried to hold on to the canopy and some part of the cockpit. He could not orient himself. He is a pilot of over 500 jet hours and never felt such a pronounced disorientation before."

He also said that alternating positive g and weightless conditions will possibly cause distress due to the time necessary for the cardiovascular reflex mechanisms to adjust to unaccustomed conditions. In spite of the fact that man's system is "calibrated" to operate in a 1 g field, von Beckh concluded that man could adapt to the unusual environment of weightlessness.

Personality structure of the volunteers for Project Mercury was examined in a report presented by members of the Aeronautical Laboratory at Wright Air Development Center. Candidates were described as intelligent, mature, deliberate and confident individuals, who are unusually well-functioning, highly-endowed persons, able to deal effectively with the complexities of manned space flight.

In other actions, the association recommended that:

- **Pilots involved** in violations or major accidents be required to submit to medical re-examination at discretion of the FAA.
- **Representative** of the Office of the Civil Air Surgeon be active on civil aircraft investigation boards.
- **Major airlines** maintain medical departments to "maintain a high degree of medical fitness for airline personnel."

Hydrodyne to Produce Minuteman Nozzles

Los Angeles—Aerojet-General Corp. has granted Hydrodyne Corp. a production contract for nozzle assemblies for Minuteman, the Air Force solid-propellant intercontinental ballistic missile. Hydrodyne has been doing engineering research and development work on Minuteman for more than a year, including purchase of machinery for production. The new work, on three types of nozzles, utilizes high temperature materials.

Minuteman nozzle system also uses the Skinner seal produced by Skinner Division of Hydrodyne. This particular seal, which withstands temperatures to 2,000F, already has been used to prevent sealing failures in other missiles.

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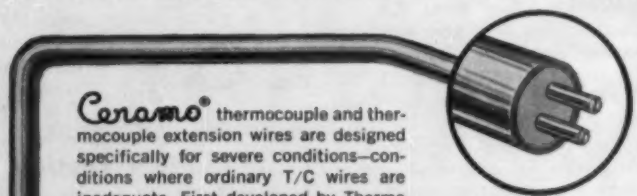

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Write for Bulletin No. 31-300-

Thermo Electric Co., Inc.
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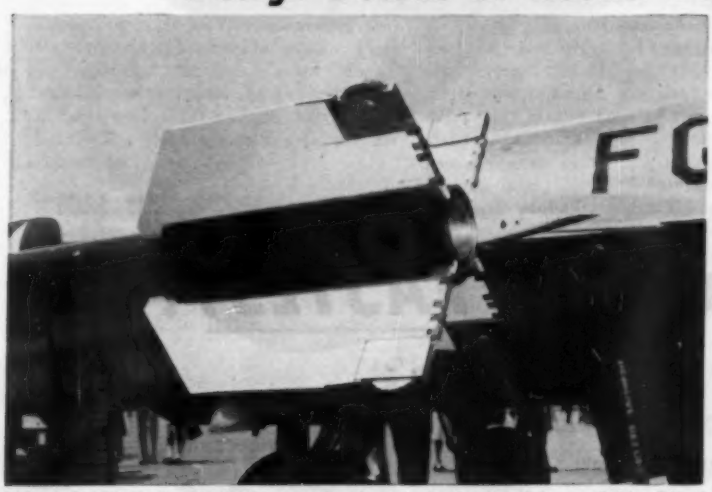
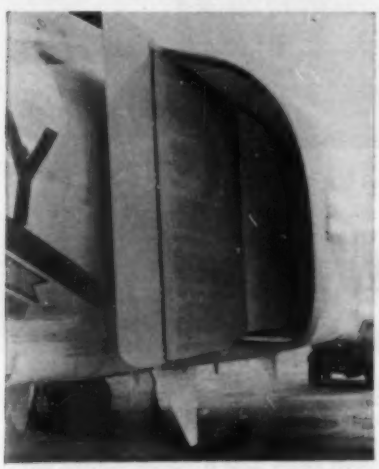
North American GAM-77 Hound Dog air-to-air missile, (left) displayed at Washington, D. C., has new convergent-divergent-convergent type nozzle to modify exhaust flow for maximum velocity. Nozzle was especially designed for GAM-77 in order to adapt Pratt & Whitney J52 turbojet engine for optimum efficiency at altitudes it is required to fly. At right, Sparrow 3 missile is installed on McDonnell F4H-1.

Design Details of Hound Dog, A3J-1, F4H-1



Sidewinder air-to-air missile fins are fitted with flywheel stabilizers (left). Missile is installed on a Lockheed F-104 fighter. At right is the left main landing gear of the North American A3J-1 Vigilante; hardware has been relatively simplified.



Variable inlet ramps are a feature of both the McDonnell F4H-1 (left) and the A3J-1 (center). Vertical ramp on F4H-1 is hinged and inlet is perforated for bleed air. Variable ramp on A3J-1 is horizontal. At right is the spike inlet for the Hound Dog's J52 turbojet engine.

world's FASTEST...

MISS JERRIE COBB, on April 13, 1959, at the World Congress of Flight, Las Vegas, Nevada, flew an Aero Commander 680E to a NEW WORLD SPEED RECORD for aircraft in its weight category, over a 2000 kilometer course. Now the fastest, Aero Commander had previously established world records for distance and altitude in 1957.

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LOOK TO THE LEADER IN BUSINESS AIRCRAFT

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Services Warn of Procurement Deficits

By Ford Eastman

Washington—Military witnesses of all three services have told the House Defense Appropriations Subcommittee that the presently-planned limited procurement of aircraft and missiles raises serious doubts as to the future U. S. defense posture. Here's how military heads viewed the situation in terms of various programs:

• **Vice Adm. Robert B. Pirie,** deputy chief of naval operations for air told the group: "I am very much concerned that the number of aircraft we have been able to buy in the last three years amounts to just slightly more than the number of total crash losses. It is obvious from that we are on a descending scale in total numbers, and it worries us considerably." Adm. Pirie also said that the numbers of Martin Bullpup air-to-surface tactical missiles in the Fiscal 1960 budget will provide slightly less than a month's supply for combat use.

Sparrow III

Number of Raytheon Sparrow III air-to-air missiles planned would provide slightly more than a month's combat supply, he said.

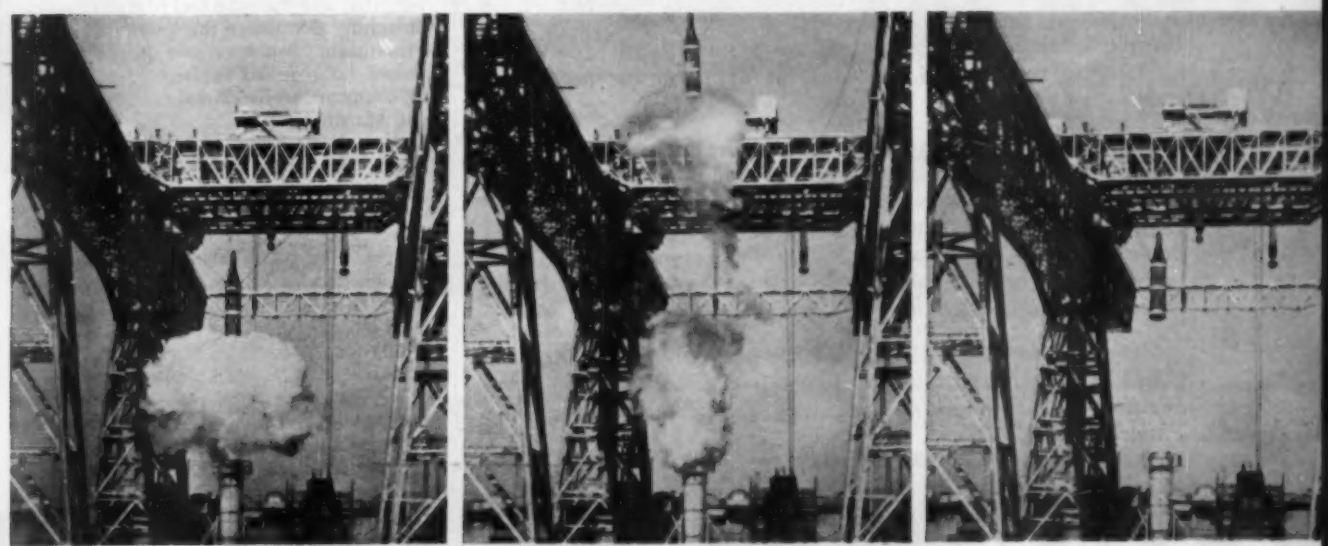
• **Lt. Gen. C. S. Irvine,** now retired, but Air Force deputy chief of staff for materiel at the time of his testimony, said: "We have steadily reduced our capability in the tactical command area each year because we just have not been able to fund it fully."

• **Lt. Gen. Bernard A. Schriever,** commander of the Air Force Air Research and Development Command, said: "I think at least for a few years our deterrent posture may well be what might be called a limited deterrent posture, or a negative deterrent posture, wherein we have only the capability to strike back and knock out his (the enemy's) economy rather than be able to knock out all his military installations. Until we achieve such a capability we will never have what I consider a positive deterrent, one that permits us to take the initiative . . . . I certainly could not forecast the day (when U.S. deterrent power would not be sufficient). However, in the face of the increased delivery capability of Soviet ICBMs, our deterrent capability, looking downstream, could very will deteriorate . . . . We will probably enter the period of maximum danger in calendar year 1962. . . . In the face of the ballistic missile threat, which is something we have never faced before but which is upon us, it is my opinion that our deterrent posture can and should be increased and improved by additional missiles during the time period of 1961 to 1963."

• **Lt. Gen. Carter B. Magruder,** Army deputy chief of staff for logistics, testified: "In my personal opinion, the Army's Fiscal 1960 budget does not contain adequate funds for the Nike Zeus (anti-missile) program. For a weapon system as critically important as Nike Zeus, I personally feel that, to be adequate, funds must provide for an operational capability at the earliest feasible date." Gen. Magruder pointed out that the Soviet Union already has an intercontinental ballistic missile capability which can be expected to increase and said the Nike Zeus is the only system under active development designed to provide a defense against ballistic missiles.

'Requirements Increasing'

• **Rear Adm. W. J. Marshall,** director of Navy's Materiel Division, said: "Our requirements for missiles are constantly increasing. However, despite the increase in dollars allocated to them, due to the increasing number of missile ships joining the fleet, the increased capacity of their magazines and the increasing unit prices for the more sophisticated missiles, the percentage of



Arresting Gear Retrieves Dummy Polaris Missile

Dummy Lockheed Polaris underwater-to-surface missile is recaptured by cables during launch stress tests by Lockheed Missiles and Space Division and Westinghouse Electric Corp. at San Francisco Naval Shipyard, Calif. At left, the Polaris replica, which contains considerable instrumentation, is fired; center photo shows the missile at point of snubbing by modified carrier aircraft arresting gear. Dummy is lowered toward ground at right, prior to removal of instrumentation and preparation for the next test. Retrieving method was devised by Navy Aeronautical Engineering Facility at Phila., Pa. Test data is analyzed at Lockheed and Westinghouse's Sunnyvale Division.

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ship-fills continues to decrease. . . . This budget represents a compromise between meeting our most urgent needs and the practical economic consideration with which we are continually faced . . ."

• **Rear Adm. W. F. Raborn,** head of Navy's Polaris fleet ballistic program, told the group: "I have a very strong feeling that in the period of 1963-1964, unless we have an adequate number of Polaris submarines on the line, equipped and ready to go, that this nation's defense capability will not be as high as it could be."

With the Fiscal 1960 budget essentially the same as that for the current fiscal year, the witnesses indicated that the military services, in attempting to maintain combat readiness and fund necessary programs, are caught in a financial squeeze between budget ceilings and greatly increased costs of newer and more modern weapon systems. As a result, funds are being allocated on a priority basis, forcing some programs to be dropped and other programs to be cut back.

Military procurement officials appearing at the subcommittee hearings indicated almost without exception that more funds should be provided for almost every procurement program—from spare parts to electronic and communications equipment, aircraft and missiles—in order to maintain an adequate defense for the future.

Gen. Schriever recommended an increased procurement of intercontinental ballistic missiles, including the Convair Atlas and the solid-fuel Minuteman programs. Because of the lower cost of Minuteman, Schriever said he felt it should be acquired in larger numbers to complement the liquid-fueled Atlas and Martin Titan.

Both Adm. Raborn and Rear Adm. K. S. Masterson, Navy director of guided missiles, called for the building of additional Polaris submarines. The Navy had requested, in Fiscal 1960 budget funds, for six additional submarines and for long lead-time items in order to schedule 12 in Fiscal 1961. This was not approved, although Fiscal 1960 budget contains funds for long lead-time items for three submarines.

Adm. Pirie said that more funds will have to be provided in the future in order to keep the aircraft carrier capability at its present level. Even though new aircraft introduced on a reduced inventory generate more firepower, or at least as much as before that of its predecessor, the number of aircraft in inventory is an important factor, Adm. Pirie said.

Rep. George H. Mahon (D.-Tex.), subcommittee chairman, agreed. "I have been intrigued somewhat by statements made by influential people in the

Space Year News

Astronautical Times

Final Edition

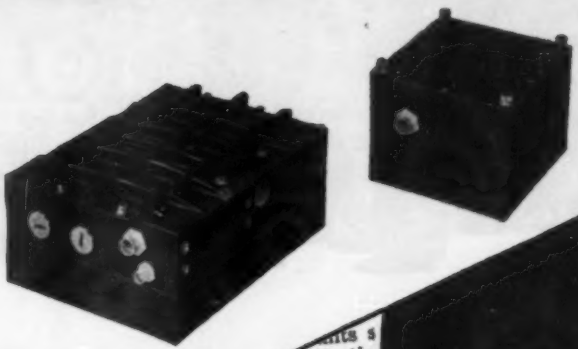
AVION RADAR BEACONS FOR ATLAS AND TITAN MISSILES

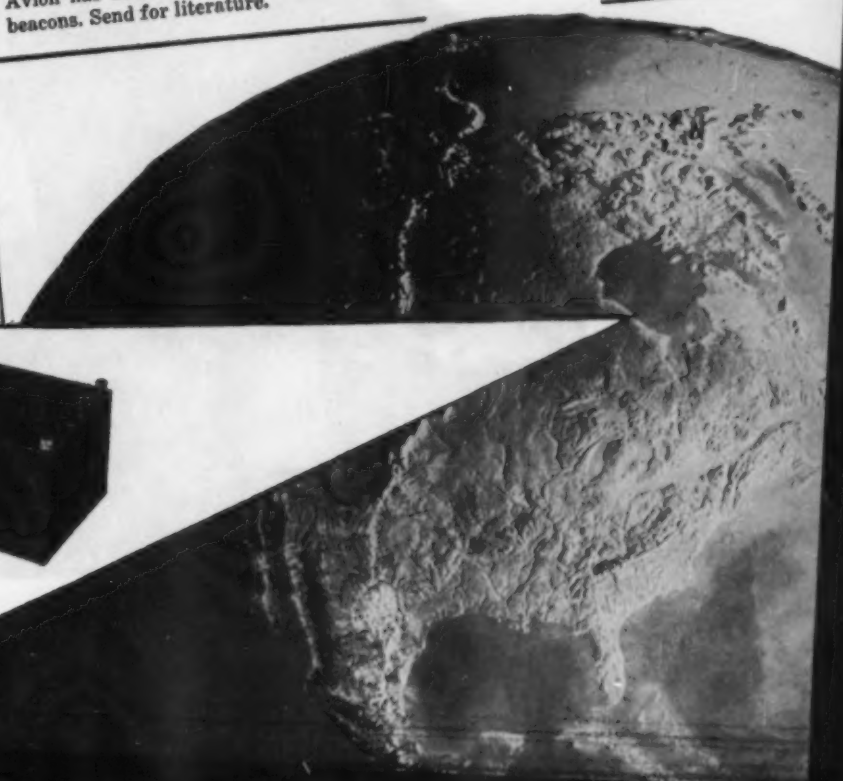
PARAMUS, N. J.—A contract for production of radar beacons to be used in the nose cone of the Atlas ICBM has been awarded to Avion Division ACF Industries, Incorporated. "This contract represents the continuation of a series

PARAMUS, NEW JERSEY—SPACE YEAR II—A contract for production of radar beacons for the U.S. Air Force Titan intercontinental ballistic missile nose cone has been awarded to the Avion Division of ACF Industries Incorporated, it was disclosed today by Richard F. Wehrlin, Avion President.

Radar beacons, Mr. Wehrlin said, are used to increase the range of ground radar while tracking the test firings of missiles, and the re-entry of nose cones, into the atmosphere.

In connection with their current space/avionic program, Avion has announced a new line of High Power C Band beacons. Send for literature.





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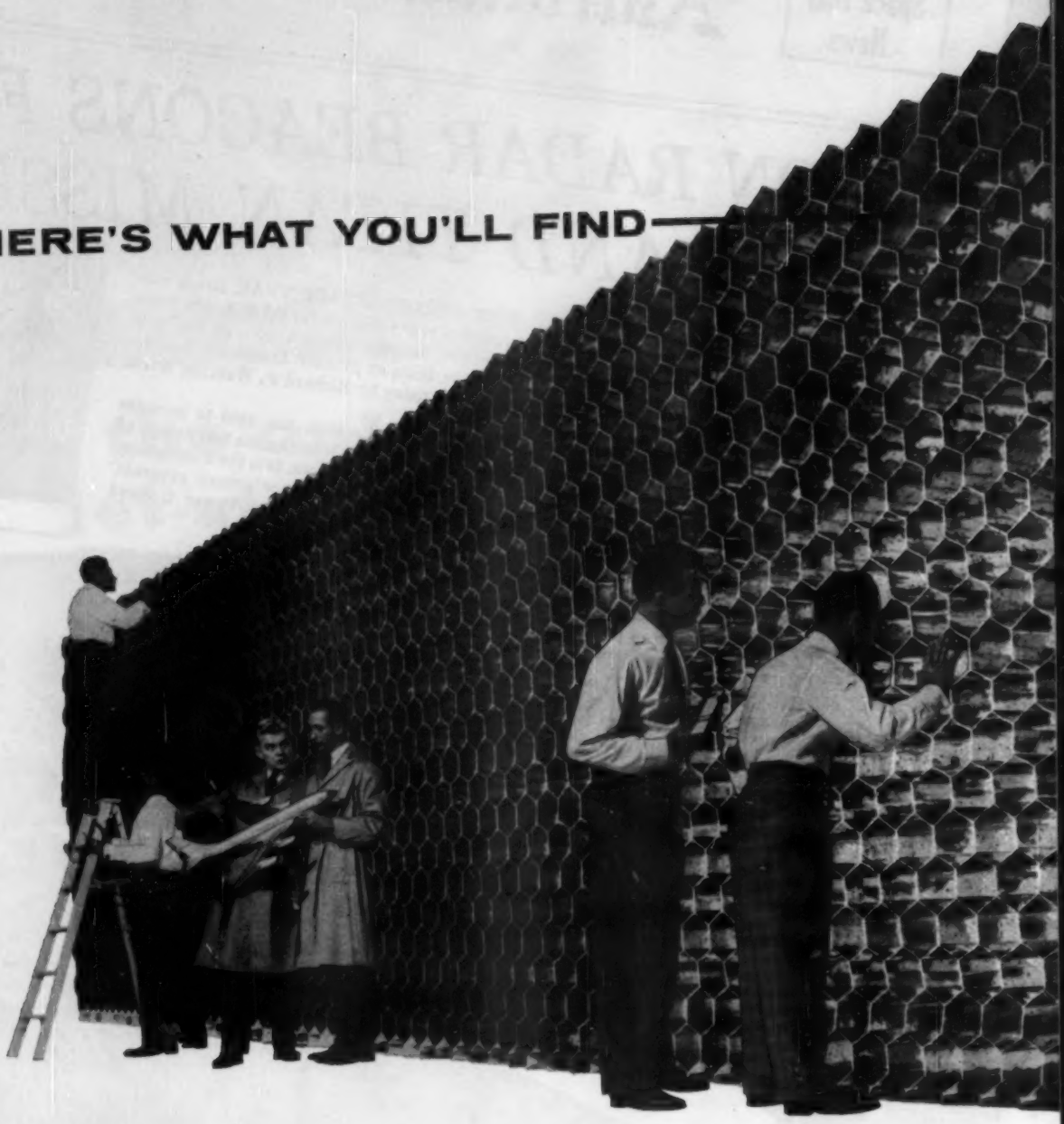

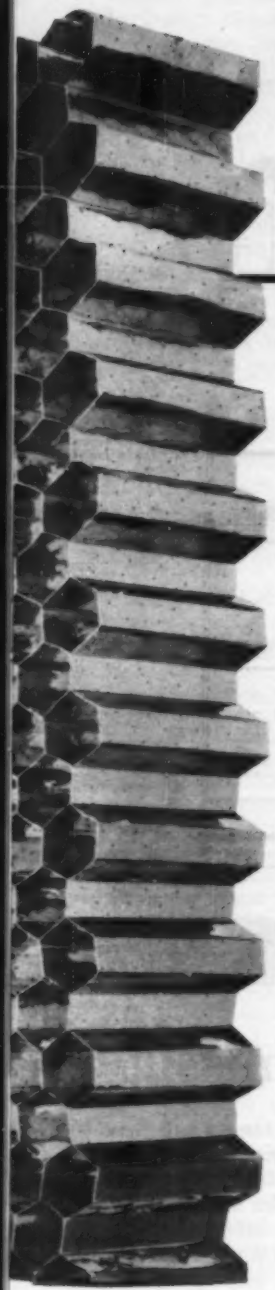

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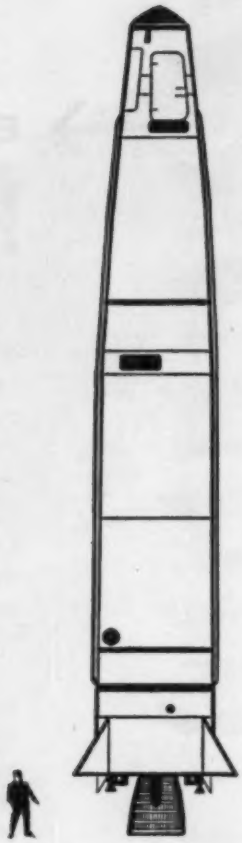
. . . are many—because of the Douglas *Thor's* versatility. As a highly mobile weapon with atomic capability, it sternly warns potential enemies against aggression. As a powerful and reliable booster, it is playing a leading role in our exploration of outer space with satellites and probes.



The missile:

. . . can destroy targets as far as 1500 miles away within minutes after hostile action is detected. Douglas *Thor* missiles were the first intermediate range ballistic missiles to be deployed overseas. The United Kingdom has announced the delivery of the first *Thors*, for operation by Royal Air Force personnel.

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government, from the President on down," Mahon said, "about the tremendous increase in firepower. There has been a disposition to say, 'we can carry in one airplane now as much punch as we could carry in all the aircraft of World War II.'

"That is a very interesting statistic but it could lead you astray, as I see it," he said. "I do not think it has been said with the necessary restrictions.

"If you want to assume the argument of reduction in absorption, you can say, 'you can put all the punch into one airplane and we have nothing to worry about because we have more punch than ever has been available in the history of man in this one airplane.' That wouldn't give you much flexibility in a war."

Earlier, witnesses testified that larger numbers of aircraft and missiles should be in the inventory because of the increasing problem of penetrating the enemy's defenses and, in the event of an attack where losses probably would be heavy, still retain sufficient forces to strike back.

Additional highlights of Air Force procurement testimony are:

• **Funding of aircraft,** missiles and support equipment for Fiscal 1960 is $8,806.5 million, a decrease of $572.6 million from the Fiscal 1959 estimate. Number of missiles to be procured in Fiscal 1960 is 1,232 as compared with 1,462 in Fiscal 1959. This is exclusive of rockets and drones. Total number of aircraft to be procured by the Air Force will be 713 as compared with 762 in Fiscal 1959.

• **Proposed Fiscal 1960** budget does not accelerate the Minuteman as completely as it is felt acceleration can be achieved. The budget program envisages weapon system development only and does not provide for operational deployment, only operational planning. An additional $87 million in Fiscal 1960 would provide sufficient funds to accelerate the Minuteman program by approximately six months.

• **No funds were specifically** earmarked for procurement of the Fairchild F-27 turboprop transport, although the Air Force says it needs replacements for its obsolete Douglas C-47s and C-54s and that the F-27 appears to be an economical airplane suitable for its purposes. However, in the matter of programing and matching the need for F-27 procurement as opposed to other requirements, USAF said it felt it was one of the programs it could get along without.

• **More consideration is being** given to turning the Military Air Transport Service into a cargo-type operation and moving personnel by commercial air insofar as practicable and in line with the airlines' capability to handle them.

• **One of the motivations** in the decision to accelerate the North American F-108 long-range Mach 3 interceptor is its ability to assist in location and identification of incoming aircraft units and the ability to get out far enough to pass information back to assist in the deployment of the Boeing Bomarc and Nike Hercules anti-missile weapons.

• **Essential component improvements** on the Pratt & Whitney J52 engine for the North American Hound Dog missile include a 150-hr. engine qualification requirement to provide additional thrust for the B-52 mother ship during takeoff. Additional improvement engineering will be required to provide an exhaust nozzle redesign to support the Hound Dog's low-level mission requirement. Additional engineering will include redesign of the engine compressor to adapt the engine to the missile inlet configuration and to increase altitude starting reliability. Efforts toward increased thrust and Mach performance, reduction of specific fuel consumption and weight and increased reliability will be continued.

• **Essential improvements** for the RJ43 Bomarc engine include redesign of the engine burner system and redesign of the inlet air flow configuration to improve component efficiency and an oxidizing system to extend altitude performance. Redesign of the engine for the use of high energy fuels is included in the program.

• **Introduction of solid state** computers in the SAGE operational program will not only expand use of the air defense warning system but also make it possible to harden SAGE facilities with greatly reduced vulnerability.

Highlights of Army procurement testimony included:

• **Reductions of about** $40 million have been made in atomic assemblies and related items in order to stay within established expenditure levels and to correlate atomic assemblies with missile production.

• **In the guided missile area,** there has been an addition of about $50 million for development of the Martin Pershing selective-range tactical missile system and $56 million in the Nike Hercules ground-to-air missile program to provide for procurement of additional ground equipment and missiles to meet the Army-approved troop program.

• **In the communications** and battlefield surveillance category, the Fiscal 1960 budget will permit procurement of a "modest portion" of the electronic equipment required by the Army.

• **Since the Fiscal 1959 budget** presentation was made to Congress, there has been some slippage in the actual production of the Martin Lacrosse surface-to-surface missile system due to difficulties during the test period last year. Procurement was reduced from $70 million

PUMP PRIMERS

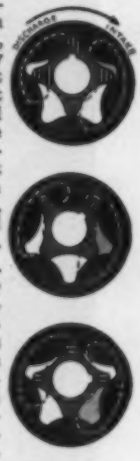
by
Arthur A. Nichols

"Why Gerotor Pumps For Servo Control?"

Hydraulic servo systems require a smooth flow of control power between sensing elements and the hydraulic systems that do the actual positioning. This calls for a positive-displacement pump that does not quit at the low end of the speed range.

The Gerotor pump is unique among all positive-displacement pumps designed for servo-control applications because of its exceptionally high volumetric and mechanical efficiency.

High volumetric efficiency is inherent in the Gerotor design and pumping cycle, *(See Fig. 1)*. The Gerotor has only two moving parts — a ring gear and a mating rotor having one less tooth. This "missing tooth" provides the fluid-moving chamber. The difference in number of teeth also causes a slow relative rotation between the two gears. As both gears rotate in the same direction around a single shaft, the chamber slowly opens and fills as it passes the intake port . . . slowly closes and empties as it passes the discharge port. Fluid-tight continuous contact of inner and outer teeth provides high suction, positive pressure and relatively pulseless flow.



High mechanical efficiency maintained over a long service life results from design simplicity which involves just two moving parts with slow relative rotation, a single shaft and closely maintained tolerances. Valveless construction and dynamically balanced parts also contribute to minimum maintenance and quiet operation.

Other applications in the Gerotor pump's 100 gpm and 1000 psi range include hydraulic motors, lube, scavenge and booster service, electronic coolant pumping in aircraft, guided missiles and similar installations.

Technical information plus complete custom engineering and precision manufacturing facilities are available to help you obtain the right pump to meet your performance and housing requirements. Your inquiry is invited.

FIG. 1

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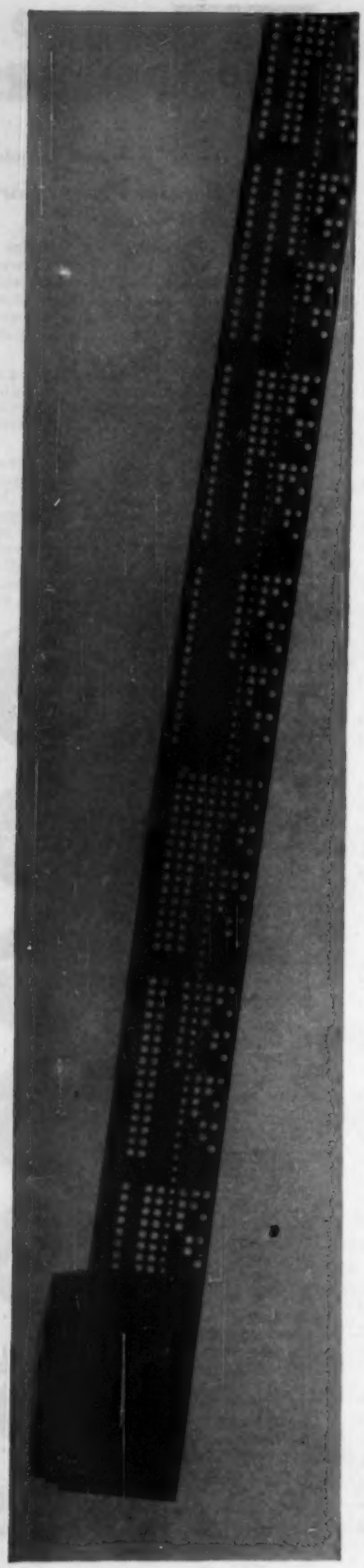

Now, completely

Honeywell's Compact Random Access Programmer, using solid state switching techniques, makes checkout and countdown fast, accurate, reliable.

When a production missile goes to the field it has to be ready—all the time.

The crew must know, first, that each system, subsystem and component crammed into the missile works perfectly; second, that after launching each will function in a precisely predetermined sequence.

This demands highly accurate surveillance and constant checks, achieved with an absolute minimum of equipment and personnel.

Programming and checkout equipment now being used is for the most part expensive and inflexible, with a low reliability factor. Logistics of coordination are puzzling and uncertain. Since thousands of conventional, mechanical relay switches are necessary, programmers are large and cumbersome; and any change in the logic of the missile system means that checkout equipment must be redesigned to conform.

Many of these problems are solved by Honeywell's Random Access Programmer, a dig[illegible] advance in the state of the art. It applies solid state techniques whereby tiny magnetic switches replace mechanical switches, making possible remarkable reductions in bulk and greatly increased signal speed, longevity and reliability.

MISSILE TEST ON TAPE

Pre-punched tape fed into compact random access programmer can monitor a missile continously through all phases of checkout and countdown procedures.

Random Access
Programmer Check
Out Equipment

automatic missile checkout

Solid state switching, random access and punched tape make the Honeywell programmer a fully automatic device that can be designed to monitor any missile throughout all phases of checkout and countdown procedures. The console contains comparator equipment that measures temperature, pressure, frequency, voltage, current, speed, time, weight, resolution and drift.

What's more, the Honeywell programmer is the only system which, when a malfunction occurs, sends a coded message to the operator pinpointing its location.

Advantages

Size. A conventional, mechanical switch with 1,024 switch points occupies 48 cubic feet. The same number of switch points in Honeywell's solid-state switch makes a package only *one-quarter* of one cubic foot.

Speed. Response steps up from milliseconds to microseconds. The new Honeywell Random Access Programmer is capable of a command rate of from 12 to 300 commands per second.

Long life. No moving parts, nothing to break, nothing to wear out. Mechanical and nuisance failures are virtually eliminated.

Flexibility. Because punched tape is the language of the system, even major modifications in the missile require merely a change of tape. No design changes in the checkout equipment are needed.

Malfunction Indication. During checkout and countdown the Honeywell device monitors the missile automatically through signals fed into it in a predetermined sequence. If a malfunction occurs, the device searches, finds and localizes it, then notifies the operator remotely by means of a coded signal. Meanwhile, the missile has been made safe. Repairs may be made quickly.

The new Compact Random-Access Programmer is essentially a data handling system. As such, it's a logical result of Honeywell's 15 years of experience in the accumulation, processing and presentation of data in practically every type of industry. The new device simply represents a wealth of competence turned to military application by the Missile Equipment Division of Honeywell's Military Products Group. It's logical, too, that the new equipment should have many points of technological superiority. For Honeywell development and production capability is devoted to producing a majority of the same missile systems and components that the programmer must check. Corporate-wide support is readily available from other divisions as needed—Datamatic, Seattle Development Laboratories, Aeronautical, Ordnance and Boston divisions, and others.

Since the corporation's business is *measurement* and *control*, the results of much research, development and production across a wide range of closely-related effort is incorporated in the work of Honeywell's Missile Equipment Division.

For a demonstration of solid state checkout—programming system, write Honeywell, Missile Equipment Division, Pottstown, Pa.

Honeywell

H Military Products Group

77

to $55 million. The difficulties have

DYNA-SOAR

Dyna-Soar (for dynamic soaring) is a joint project between the Air Force and the NASA, and is an attempt to solve the technical problems of manned flight in the sub-orbital regions. Advance knowledge on the project indicates how a boost-glide vehicle can operate from the outer fringes of the atmosphere where it can maneuver and be recovered undamaged. Studies show that by varying the original rocket boost, and thus the velocity, and with the control available to the pilot, the Dyna-Soar aircraft can circumnavigate the earth, followed by a normal and controlled landing. Boeing Airplane Company, one of the competing companies for the development contract for the complete boost-glide system, has delegated to RCA the responsibility for the development of important electronic components of Dyna-Soar.

RCA **RADIO CORPORATION of AMERICA**

DEFENSE ELECTRONIC PRODUCTS
CAMDEN, N. J.

Tm(s) ®

to $55 million. The difficulties have since been corrected and the system is again in production.

• **Of the $52 million in additional** funds authorized by Congress in Fiscal 1959, the Army received $6 million and was informed that the remaining $46 million would be held available against the Fiscal 1960 new obligational authority requests. Highlights of Navy procurement testimony included:

• **Navy canceled its requirement** for a nuclear-powered aircraft carrier in the Fiscal 1960 budget because there were too many other items in the budget that it felt should take priority within the framework of available funds.

• **Recommendations to accelerate** the Polaris program in Fiscal 1960 and Fiscal 1961 were made in order to reduce by half the gap between ready-for-sea dates and the operational dates of the submarines.

• **Total of 45 Polaris** submarines would give the Navy an adequate number to permit it to keep an adequate percentage on station at all times.

• **Conversion of the Lockheed** Electra turboprop transport to an anti-submarine warfare replacement aircraft for the Lockheed P-2V will give the Navy a high speed and altitude capability plus more internal volume for search and detection gear.

• **Through Fiscal 1959,** a total of $39 million has been made available or obligated for the Temco Corvus air-to-surface missile which has both atomic and conventional warhead capability. Last year, the program slipped behind schedule because of technical difficulties, but the project is now approaching its schedule.

• **There has been a slippage** of about four months in the entire class of guided-missile destroyers due to difficulties in the new weapon systems incorporated in the ships and the electronics equipment.

Rolls-Royce Sales Up But Costs Cut Profits

London—Although sales by Rolls-Royce, Ltd., increased by more than $11 million last year, heavier costs reduced profits by more than $500,000, according to the company's 1958 accounts.

Total sales last year were valued at $267 million, 4% more than in 1957. Manufacturing, administration, research and development costs were $6 million higher, at $256 million. After tax deductions there was a net profit of $5.8 million, compared with $6.5 million the previous year.

The 20% dividend is maintained and company has proposed a one-for-one script issue of new ordinary and workers' (1955) shares.

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Aircraft industry applications

Northrop Aircraft, for example, uses Fairchild Facsimile to save valuable time in transmitting engineering data between Hawthorne, Calif., and Cape Canaveral. Douglas Aircraft, in fast 3-way communication between Santa Monica, Long Beach and Edwards Air Force Base in California, finds Fairchild Facsimile's extreme clarity of special benefit. Often, on receiving change order facsimiles, an engineer will make pencil notations thereon and retransmit them to another point.

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FREE-FLOATING horizontal stabilizer on Cessna CH-1C is 80% larger than that of YH-41. Note 15-gal. auxiliary gas tank aft of cabin door.

Aviation Week Pilot Report:

CH-1C Shows Stability Characteristics

By Robert I. Stanfield

Washington—Cessna Aircraft's new, all-metal, four-place CH-1C helicopter, a much-modified derivative of the military YH-41, showed excellent longitudinal, lateral and directional stability characteristics—including a brief span of hands-off flight—during a flight evaluation by AVIATION WEEK.

The light, multi-purpose utility rotorcraft was designed for reconnaissance-observation, personnel transportation and as a pilot and instrument trainer. It is powered by the six-cylinder, supercharged, piston-driven Continental FSO-526A, which develops 270 hp. at 3,200 rpm. at takeoff. Fuel grade is 91/96 octane.

Cessna has invested more than $3.5 million in its rotorcraft development program. Following certification by the then Civil Aeronautics Administration, 10 of its YH-41s were delivered to the Army between August, 1957, and January, 1958 (AW June 4, 1956, p. 95) at an over-all estimated contract cost—including spares, ground handling equipment, flight data, air frames—of $1,129,000, including government furnished aircraft equipment.

Major CH-1C modifications and flight characteristics evidenced during evaluation by AVIATION WEEK, embraced the following areas.

• **Directional control.** Tail rotor blade center of pressure has been relocated with respect to pitch change axis by "sweeping" blades (tail rotor is swept back 3.5 deg.). There was little or no oscillation apparent during level flight in the CH-1C.

• **Hands-off flight.** New horizontal rectangular stabilizer, free-floating, is 80% larger than that of the YH-41. In hovering it aligns itself with rotor downwash; in forward flight it aligns itself against up-stop connected to the collective stick. Hands-off flight of about 30 sec. was made with no pitching tendencies.

• **Lateral stability.** Mechanically-driven gyro, connected to the lateral servo system, is installed in the CH-1C (there is no electronic stabilization equipment in this helicopter). The device actuates lateral cyclic control through mixing linkage. There was no lateral motion in hover, cruising flight and during power changes. When the gyro was deliberately cut off, the helicopter had a tendency to roll.

• **Autorotations.** Characteristics were good during autorotations from 1,000 ft. with wind at 10 kt. Rotor speed decay, a reported peculiarity of the YH-41, has been rectified in the CH-1C by modification of linkages in the control system. Addition of an accumulator to the collective boost system more than doubles the rate at which the collective can be reduced. High collective pitch stop was increased 4 deg.

Maximum gross weight of the CH-1C is 3,100 lb. Empty weight is 2,065 lb. The two-blade, all-metal rotor is 35 ft. in diameter

Cruise speeds range from 80 to 105 kt. Rate of climb, sea level, is specified at 950 fpm.

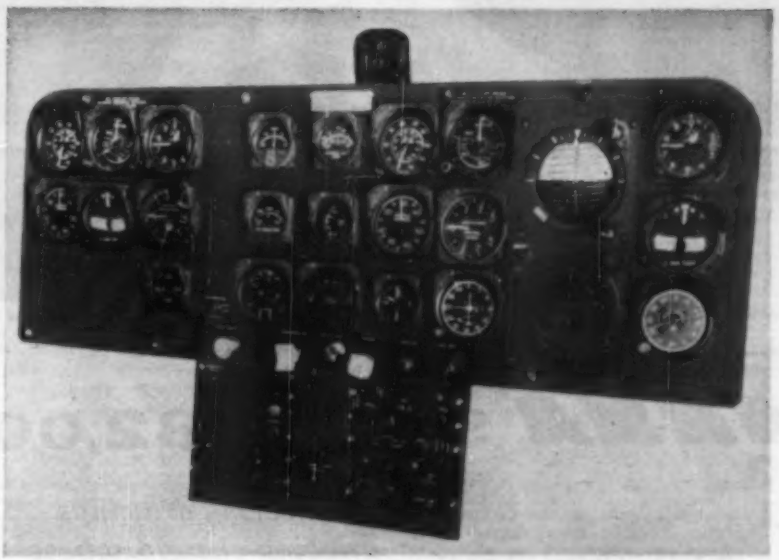
The helicopter flown by AVIATION

FOUR-PLACE version of the CH-1C is a modification of the military YH-41 helicopter. Instrument panel is shown at right.

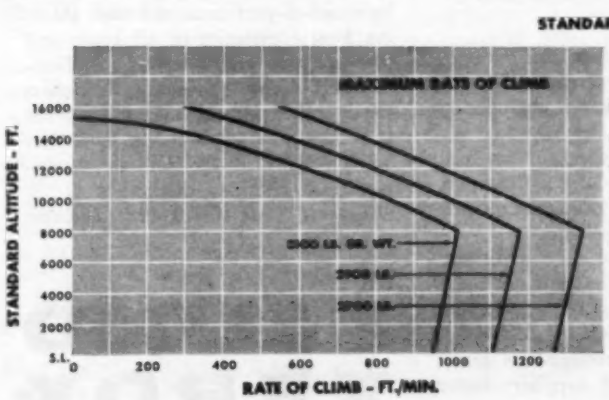
CH-1C Specifications

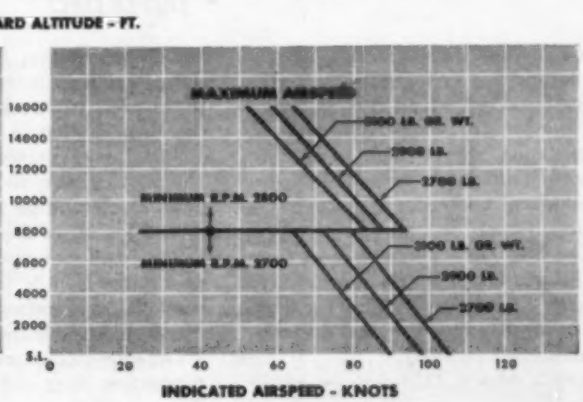
Maximum gross weight	3,100 lb.
Empty weight	2,065 lb.
Useful load	1,035 lb.
Fuel capacity (standard)	60 gal.
Fuel capacity (with two auxiliary tanks)	90 gal.
Main rotor:	
Number of blades	2
Rotor diameter	35 ft.
Blade chord	13 in.
Disk loading	3.22 lb./sq. ft.
Tail rotor (2 blades) diameter	7 ft.
Power loading	10.3 lb./hp.
Height to top of cabin	85.9 in.
Height of rotor	96 in.
Over-all height	101 in.
Fuselage length	392 in.
Over-all length	512 in.
Fuselage width	64 in.
Over-all width	99.75 in.
Cabin volume	201 cu. ft.

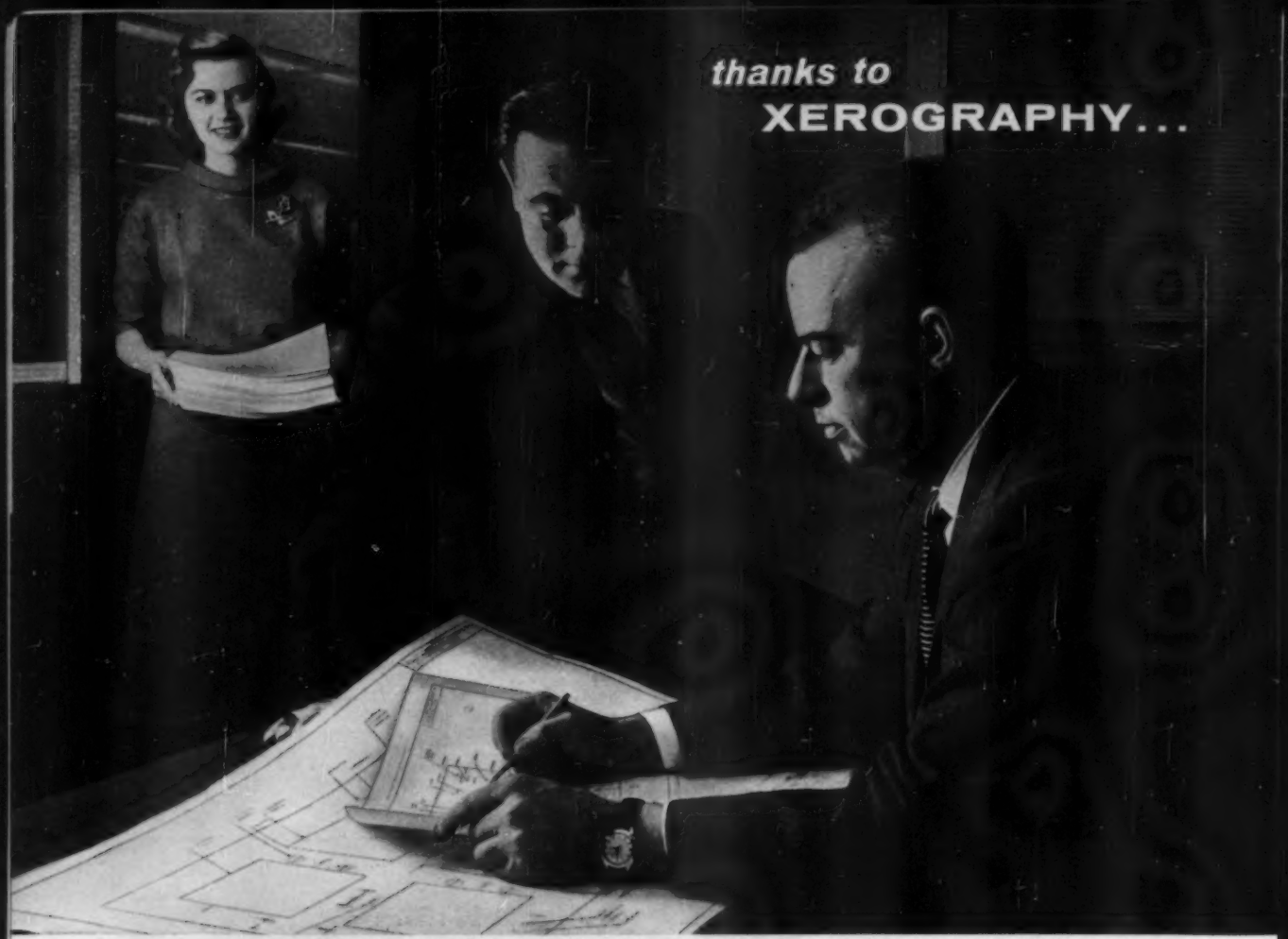
Engine: Continental six-cylinder, supercharged, air-cooled FSO-526-A developing 270 hp. at 3,200 rpm. at takeoff.



PANEL for instrument trainer version includes radio controls at lower center (above). Charts below show rates of climb and maximum airspeeds at weights up to 3,100 lb.







Robert Harding, right, assistant chief engineer of Arma division, American Bosch Arma Corporation, points out to Frank McShane, cost-improvement expert, the high quality and contrast of an 11"x17" stock print reduced from an original 22"x34" drawing. The print is a sample of many run off on an offset duplicator from an inexpensive offset paper master prepared xerographically by XeroX Model 1218 copying equipment.

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XeroX Model 1218 copying equipment, operating on the principles of xerography—clean, fast, dry, electrostatic—prepares inexpensive offset paper masters from original engineering drawings of A to D size.

The larger drawings are reduced with fine legibility to 12"x18" masters, from which multiple prints are quickly run off on offset duplicators.

The quality of copies is superb. Yet, prints cost so little that engineers are encouraged to discard them after use, rather than re-file them.

Drawing-change notices now reach production lines and suppliers faster than ever before.

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CH-1C Performance

Maximum speed (sea level, 2,700 lb.)	106 kt.
Cruising speeds	80 to 105 kt.
Rate of climb (sea level, 3,100 lb.)	950 fpm.
Time to climb, sea level to 10,000 ft.:	
2,700 lb.	7 min. 44 sec.
2,900 lb.	8 min. 50 sec.
3,100 lb.	10 min. 16 sec.
Hovering ceiling (in ground effect, standard conditions):	
2,700 lb.	13,500 ft.
2,900 lb.	11,600 ft.
3,100 lb.	9,600 ft.
Hovering ceiling, 95F, 3,100 lb., in ground effect	6,500 ft.
Range (normal fuel)	226 naut. mi.
Range (with auxiliary tanks)	347 naut. mi.
Endurance (normal fuel)	3.37 hr.
Endurance (with auxiliary tanks)	5.15 hr.
Operating rpm. range:	
Continuous	2,700 to 3,000 rpm.
Takeoff 5 min	2,700 to 3,200 rpm.

WEEK, N5159, was the three-place instrument trainer currently being demonstrated to the military. Cessna has not closed the door to commercial production, but is working toward a military contract for the CH-1C.

This compact rotorcraft sits on two tubular aluminum skids, each attached to the fuselage by two struts. Steel tension straps are installed between strut and fuselage castings to absorb landing shock.

The lower side of each skid is protected by a replaceable steel shoe. Detachable wheels provide for ground handling.

The engine is located forward of the cabin section. Power is transmitted to the main and tail rotors through a simple drive train consisting of a centrifugal clutch, freewheeling unit and a spiral bevel reduction gear system. The metal anti-torque tail rotor, of 7 ft. diameter, sits high on the tail boom.

CH-1C Interior

Interior of the CH-1C is well tailored. Entrance is via large cabin doors adjacent to upholstered front seats. The cabin is roomy and comfortable. Forward location of the engine allows for all-around glass area, tinted forward, and excellent visibility in all directions.

Seating configuration of this instrument trainer includes but one seat in the rear, aft of the front right seat, for carrying an observing student during training missions. Both front seats are adjustable fore and aft.

Demonstrator, equipped for instrument operation, contains a large panel with three rows of instruments. Engine gages are centered. Dual flight instruments are located both to the left and right sides of panel. Demonstrator also is equipped with a five-inch attitude gyro and five-inch directional gyro, seated to the right on pilot's side. Vertical speed indicator is the instantaneous type.

Radio configuration is centered at the base of the main panel. The demonstrator carried a Wilcox 702 marker beacon receiver, Wilcox 700 glide slope receiver, ARC-21 ADF system, ARC 210 receiver and transmitter. The VHF transmitter covers 360 channels.

Controls were dual. Cyclic stick grips incorporate a trigger-type switch for microphone operation and push-button switch for retrimming cyclic forces to zero. The collective stick grip includes a twist-grip throttle, adjustable throttle friction nut, and actuation switches for starter and landing lights. Collective friction is adjustable.

With two aboard, plus weight of instrumentation and 216 lb. of gasoline, the CH-1C grossed 2,781 lb. at takeoff. Sea level pressure was 29.80 in. Wind was from the south at 10 kt. Outside air temperature was 70F. For comfort, the windows set in the lower portion of each cabin door were opened for ventilation.

Hinged windows swing up and out; at maximum they can be opened only partially.

First Takeoff

Engine fired up quickly and instruments went right to the green. Power was increased to 1,500 rpm. until tachometer needles lined up. Magnetos were checked at 3,000 rpm. Takeoff was made at 3,200 rpm.

Climb was made at 3,000 rpm. and 30 in. manifold pressure. Speed in climb was 55 kt.; rate of climb 800 fpm.

During a succeeding takeoff, at 33 in. and 3,000 rpm., 55 kt. indicated, rate of climb initially was 1,000 fpm. Visibility in flight was excellent on all sides. Vibration was not excessive; conversation was made via interphone.

At 500 ft., level attitude, pulling 27 in. manifold pressure and 3,000 rpm., the CH-1C indicated 72 kt. Advancing power to 28 in., with rpm. holding at 3,000, indicated speed increased to 77 kt. At 30 in. and 3,000 rpm. airspeed will hold at 100 kt.

Constant rpm. is maintained in the CH-1C by setting cruise rpm. and locking the throttle grip with friction. Once locked, helicopter can be flown from takeoff to landing without making adjustment to rpm.

CH-1C's gyroscope, from which stems the helicopter's excellent lateral stability, operates the lateral cyclic control system through the boost system. It is driven mechanically through a shaft from the main rotor gear box and turns

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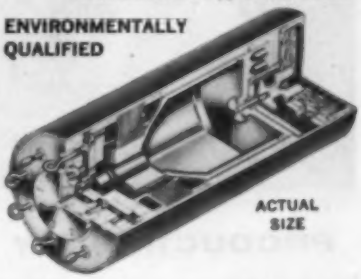

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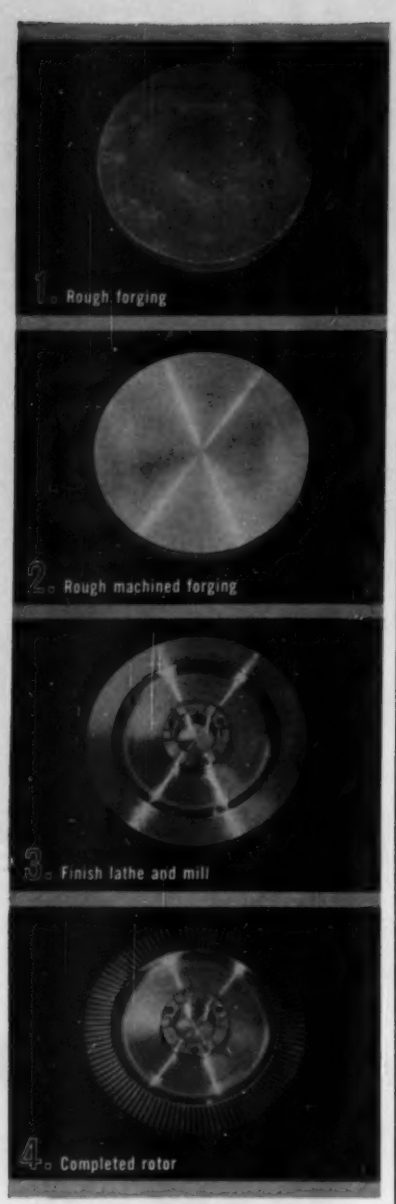

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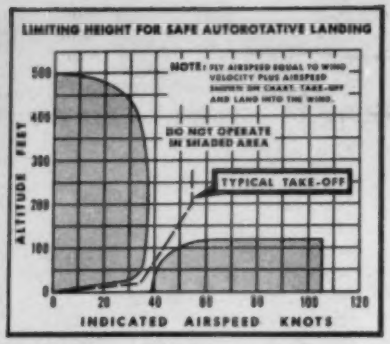


RATE of descent during autorotation evaluation was about 1,500 fpm.; chart shows critical areas of operation.

at all times when the rotor is moving.

Hands-off flight was made straight and level, and in moderate bank. When the gyro was cut off, the helicopter instability was immediately apparent, and there was a tendency, when power also was cut, for the aircraft to roll.

Weight Categories

During evaluation, the CH-1C was not flown above 2,000 ft. Army has flown the helicopter to 30,355 ft. in two weight categories (1,102 to 2,204 lb. and unrestricted), and reached 28,200 ft. in the 2,204-lb. to 3,858-lb. weight category (AW Jan. 13, 1958, p. 30). The YH-41 also was operated from 9,500-ft. test site at maximum gross weight with a 200-lb. overload.

Normal landing approach is made at 3,000 rpm., holding 60 mph. indicated. The rpm. was advanced to 3,200 for flareout at zero airspeed. Hover was made at 3,200 rpm. and 32.5 in., with turns easily made left and right, and at 30 in. manifold pressure and 3,100 rpm. Directional control is good.

Autorotations were made from 1,000 ft. Airspeed was held about 55 kt., rate of descent was about 1,500 fpm. Engine rpm. was 2,700; the rotor held at 275 rpm. Throttle was increased to 3,000 rpm. for recovery. Flight characteristics were good; rotor speed was satisfactory during the flare. High idle switch (2,200 rpm.), set well below rotor redline, will stem engine stoppage in acceleration; keep rpm. out of idle-adjustment-sensitive range.

Improvements Added

Cessna, which is now demonstrating the CH-1C to the Army and Navy in its instrument trainer configuration, will exhibit the rotorcraft to the Air Force next month at Strategic Air Command headquarters, Omaha, Neb. In addition to previously mentioned modifications over the earlier YH-41, Cessna has incorporated the following improvements into the CH-1C:

• **Exhaust system.** That system on the YH-41 emitted flames and presented a fire hazard in grassy areas. CH-1C will incorporate augmenter-type tailpipes which mix exhaust gas with cold air.

• **Auxiliary fuel pump.** To offset inconsistent pressure that could stem from presence of small foreign particles in fuel, a fine-mesh filter has been provided at the fuel tank outlet, in place of coarser filter screen used on the YH-41.

Fuel is supplied to the FSO-526A engine from two rubberized fuel cells of 30 gal. each, located on each side of the fuselage under the floor boards. Cells are interconnected to act as one tank and selection of fuel from individual cells is not possible. Only the right cell supplies fuel directly to the engine.

Small auxiliary 15-gal. fuel tanks, attached externally to sides of the fuselage, just aft of the cabin doors, can be provided to extend helicopter's endurance from 3.37 hr. to 5.15 hr.

Hydraulic boost system, eliminating stick forces, is incorporated into the main rotor flight control system. The pump is located in the tail cone and is powered by tail rotor drive shaft. Pressure is available in all flight conditions, including autorotation following engine failure.

Boost Failure

In event of boost failure, the helicopter will fly satisfactorily via mechanical controls.

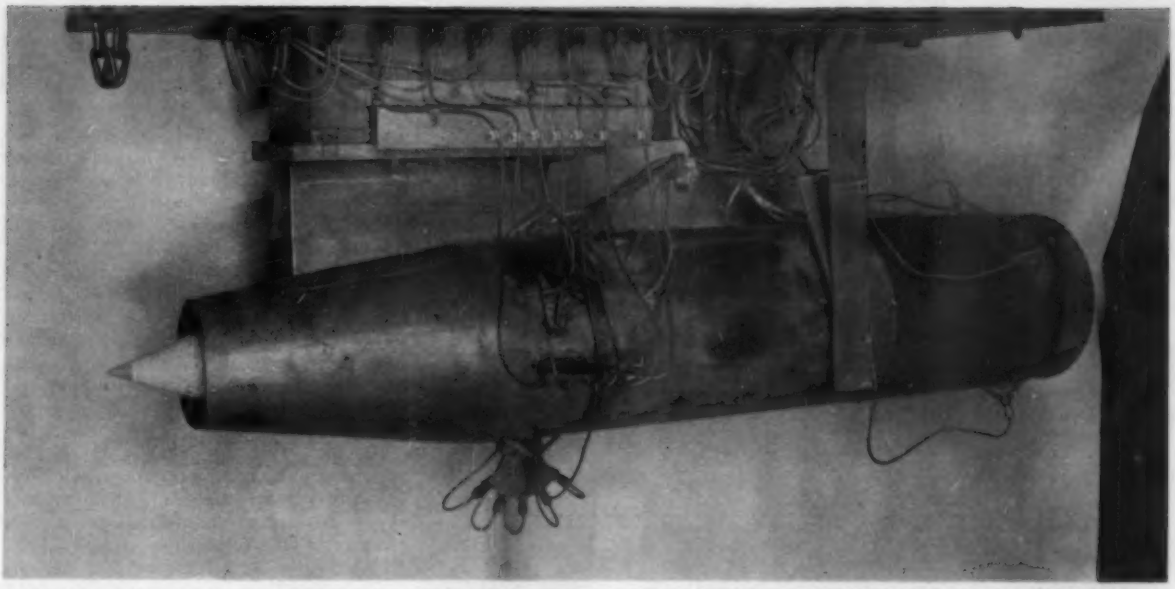
Electrical energy is provided by a 24 vdc. system, powered by a belt-driven generator located in the tail-cone.

The generator is driven by the tail rotor drive shaft which, during autorotation, is powered by the main rotor. No power loss occurs in event of engine failure.

Two 12-v. batteries, of 24 amp./hr., located in the fuselage midway between the cabin and horizontal stabilizer, serve as a standby power source. Current also can be supplied externally.

Russians Claim Records

Russia claims to have set two more altitude-with-load records with its twin-turbine engine Mil Mi-6 helicopter. Operating from a Moscow airport, the Soviet craft lifted 11,025 lb. to a height of about 18,045 ft. "besting the previous mark of 12,200 ft. set in 1956 by a similarly-loaded Sikorsky S-56," the Russians contended. Two hours after the 5-ton flight, the Mi-6 lifted 22,050 lb. to an altitude of about 16,405 ft., surpassing a Mi-6 mark set in 1957. One of the Mi-6's most notable feats, also accomplished in 1957, was to lift 26,460 lb. to an altitude of 7,870 ft.



ALLISON pyrophoric ramjet engine, designed as a lightweight powerplant for supersonic target drones, is rigged for testing in altitude environment simulator. Engine is about 3 ft. long, 8¾ in. dia. and weighs 11 lb., including 2¼ lb. control system.

Pyrophoric Fuel Reduces Ramjet Weight

Indianapolis—New pyrophoric ramjet engine, developed by Allison Division of General Motors for low cost, lightweight, supersonic target drones (AW May 18, p. 30), will probably be offered, with some modifications, as a prime powerplant for missiles as well.

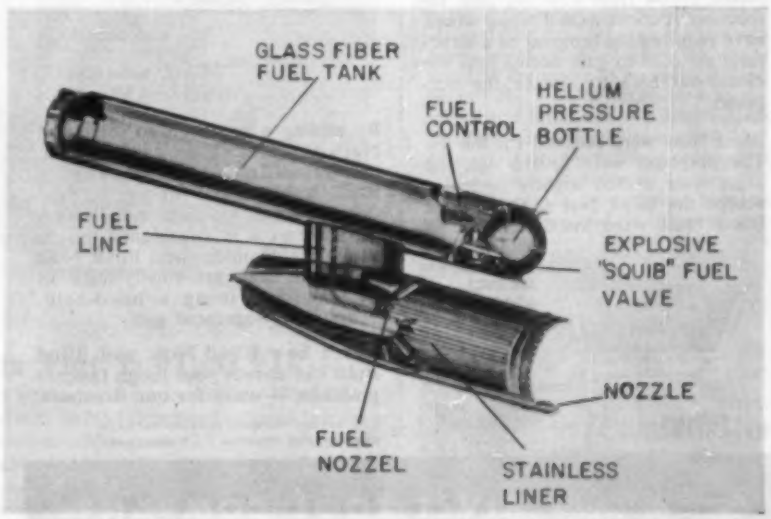
The original PD-37 Pyrodyne propulsion unit which Allison built to test the feasibility of pyrophoric fuels for a low cost, high performance drone engine proved such an efficient testbed, according to company engineers, that all basic development objectives were accomplished without requiring the manufacture of additional engines. The next step, once a contract is obtained, will be application development for a specific vehicle and then production.

Approximately 3 ft. long and 8¾-in. in diameter, the engine weighs only 11 lb., including its 2¼-lb. control system (but not the fuel and helium pressure tanks). Based on a typical performance profile of Mach 2 at 70,000 ft., it is estimated that the engine will produce a nacelle thrust of 60 lb., have a nacelle specific fuel consumption of 3.85 lb./lb.-hr. and an operation time—boost plus cruise—of 12.6 min. Cost of the engine is placed at $25 per pound of thrust.

Over-all configurations of future production models of the PD-37 are not expected to vary markedly from Allison's prototype nor from each other. But, as the company points out, the operation of each engine will be geared to the vehicle it will power and the mission. The engine, for example, can be designed for a single point operation, say at Mach 3 and 80,000 ft., by optimizing inlet configuration and setting the fuel flow regulator for these conditions. Or by changing the inlet configuration and inserting an additional (barometric) fuel/air flow regulator, Allison engineers can design the engine for operation over a range of altitudes and speeds at a slight compromise of the optimum single point operation.

Original requirements called for a small ramjet engine to power air-launched, supersonic target drones over a wide flight spectrum, a large segment of which appeared best suited to turbojet operations. Minimum weight and cost were emphasized. (A limiting maximum gross weight of 600 lb. for the complete vehicle has since been removed to accommodate other requirements the military considers more important.)

To Allison engineers, these requirements indicated the use of pyrophoric



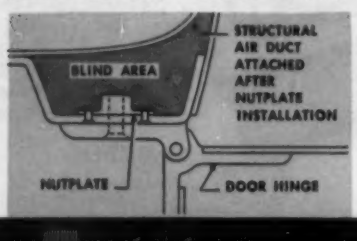
PD-37 PYRODYNE pyrophoric propulsion unit will be offered by Allison as an integral unit consisting of ramjet engine, prepackaged fuel tank, flow regulator and pressure vessel.

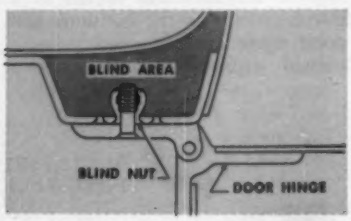
Blind Nut FIX

KEEPS AN F-104 ON SCHEDULE

Two damaged nutplates attaching the main landing gear door hinge to the fuselage threatened to keep a completed F-104 from entering final inspection. A conventional repair would have required the removal of a structural air duct to gain access into the closed-out area to replace the nutplates.

Blind Nuts were selected for the fix. The nutplates were drilled out, the holes were drilled slightly larger to accept the Blind Nut O.D. and the Blind Nuts were installed. The fix was successfully completed in a few minutes, a time consuming and expensive repair was eliminated and the Starfighter moved on schedule into final inspection.





By adding a core bolt to the Blind Nut's two piece basic configuration, this versatile fastener becomes a Blind Bolt suitable for use in tight quarters for production, modification or repair work in aircraft and missile structures. Stainless steel Blind Nuts and Blind Bolts are quietly installed by one man using a hand-held, hydraulically-operated gun.

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fuels. Under operating conditions best suited to turbojet engines, the ramjet burner pressure, without benefit of the turbojet's compressor, would be much less than that of the turbojet. Static tests indicated that pyrophoric fuels would ignite and burn at low pressures where hydrocarbon fuels would not. Spontaneous ignition eliminated the need for an ignition system which would take much of a small engine's weight. Two other important characteristics of pyrophoric fuels, high reaction rate and short ignition delay, made possible significant savings in the size and weight of the burner and combustion chamber.

The Pyrodyne propulsion unit, as offered by Allison, will be an integrated package consisting of fuel tank, fuel regulator, pressure bottle and ramjet engine. The engine is approximately 30% shorter than that of a hydrocarbon-fueled ramjet producing comparable thrust. The combustion chamber has a corrugated steel liner with air passages between liner, outside wall of engine.

The ramjet engine can be placed in the body of the drone, but Allison engineers prefer to see only the tanks and fuel control system in the vehicle and the engine itself dropped underneath the missile. This approach reportedly does not interfere significantly with vehicle performance and enables Allison to handle and test the propulsion unit as a complete package.

Theoretically, the PD-37 can burn any of the pyrophoric fuels such as trimethylaluminum (TMA), triethyl aluminum (TEA), or triethylborane (TEB). All these fuels, as the term pyrophoric implies, will ignite spontaneously upon contact with air. But Allison uses an explosive-actuated valve to start the fuel flow. This valve is located just aft of the fuel tank itself and, says Allison, makes handling of the prepackaged pyrophoric propulsion unit as safe as handling any sealed vessel containing ignitable chemicals or fuels.

Allison has carried out most of its work on the PD-37 using TEA because it is the least expensive. TMA proved to be most reactive, but suffers from a comparatively high freezing point (59F) and a limited liquid range. Allison found that mixing the two in a ratio of 25% TMA to 75% TEA resulted in a fuel with a lower freezing point (−75F) than either of the component fuels and a higher reaction rate than straight TEA.

Present price of TEA is approximately $5/lb. But sometime this year, Stauffer Chemical Co. and Hercules Powder Co., in a joint venture, will bring a large commercial plant into operation, at which time the price of TEA is expected to drop to $2.50/lb. With the development of a large market, the price might possibly drop to 25 cents/lb. in heavy tonnage purchases.

Canadians Test HU-1 in Icing Rig

Bell Helicopter Corp. HU-1 undergoes icing tests in an icing test rig at Canada's National Research Council's Ottawa Laboratories.

X-15 Rocket Engines Ready for Installation

Interim engines for North American Aviation's X-15 research vehicle have undergone ground testing and evaluation at Edwards AFB, Calif., and are ready for installation in the aircraft. Two engines, XLR-11-RM-5, built by Reaction Motors and developing more than 12,000 lb. thrust, will be installed for first flights.

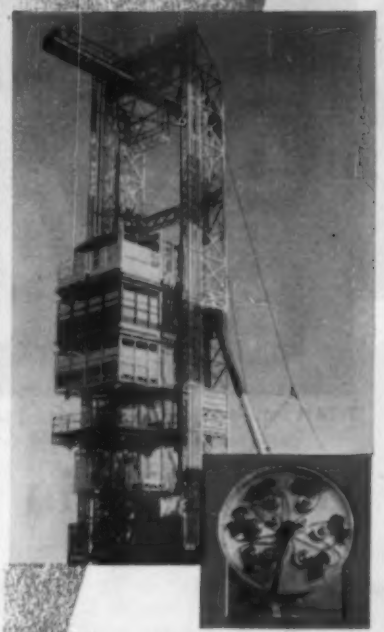
Ultimate engine for the X-15 will be the SLR-99 also built by Reaction Motors, having more than 50,000 lb. thrust.

Functional test firings of these engines have been completed and extensive instrumentation of engine performance provided data for analysis and evaluation of the powerplant and propellant system. Engines were fired more than 40 times, some firings simulating mission operations with test pilots.

Italian Air Force Tests Fiat G.91, G.91R

Fiat G.91 fighter (left) and G.91R reconnaissance version are in service with the 103rd Light Fighter Group of the Italian air force. The aircraft, in NATO camouflage paint, are stationed at Pratica di Mare near Rome for operational suitability tests. G.91s were integrated into the group, replacing the Republic F-84F fighter-bombers which formerly equipped the unit. Camera nose installation on the G.91R uses the right armament bay for electrical equipment associated with the cameras and leaves the left bay free for paired .50-cal. machine guns. Standard armament of the fighter version is four machine guns plus a wide variety of external stores.

In Redstone Gantry Tower ...YUBA Instrumentation



When tons of steel gantry tower for the Redstone Missile are raised into position at White Sands, New Mexico, both parallel sections must move at the same speed and at the same exact angle. To eliminate the possibility that stress differences between the two sections might effect the precise movement of the tower to its vertical position, Yuba was commissioned to develop and build the required instrumentation into the tower control. This type of instrumentation is typical of Yuba's contributions in the missile field. Whatever your need, Yuba has the capabilities and facilities to produce to your strict specification—with minimum lead time.

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TITAN battleship lower tank is erected in Martin-Denver test stand D-1, used only for battleship firings. Upper tank is at right.

How Martin Static-Tests Titan ICBM

By Richard Sweeney

Los Angeles—Details on the static test program of WS-107A-2, USAF Titan ICBM, as outlined by Air Force Ballistic Missiles Division here, include a comprehensive outline of the over-all test philosophy behind the Martin-designed two-stage missile.

The test program for Titan, coupled with air-lifting the missile to Cape Canaveral, Fla., is a major factor in the speed with which these missiles have been readied for flight, according to Ballistic Missiles Division. A secondary effect, BMD says, is the quantity of data available for application to later missile systems.

The majority of the test program, including final tests, is conducted at the Martin facility near Denver. The test complex for Titan was designed around the test program which was evolved for the missile.

The Titan test program has been laid out in a pyramid shape. At base level are individual components tests, product environmental tests (PET), and quality control. The pyramid's second level includes assemblies test, test of subsystems and systems. The third level is the missile compatibility firings (MCF), when the missile is hot-fired at Denver. Top of the pyramid is the flight test from Air Force Missile Test Center, Cape Canaveral.

Early testing of the Titan started when the missile first was conceived. This testing was to find a way to weld an aluminum alloy with a high copper content, which had a very favorable strength-to-weight ratio, but was considered unweldable. The alloy was chosen due to its strength-to-weight ratio, and six months of testing was conducted before a suitable method of welding was found. Testing was accomplished at Martin-Baltimore and American Machine & Foundry, until the weld met specifications.

Skin Forming

Forming of the extruded and integrally stiffened aluminum panels which make up the Titan skin was a problem which was solved by design of unique machines at Hufford Co. (AW Sept. 23, 1957, p. 37).

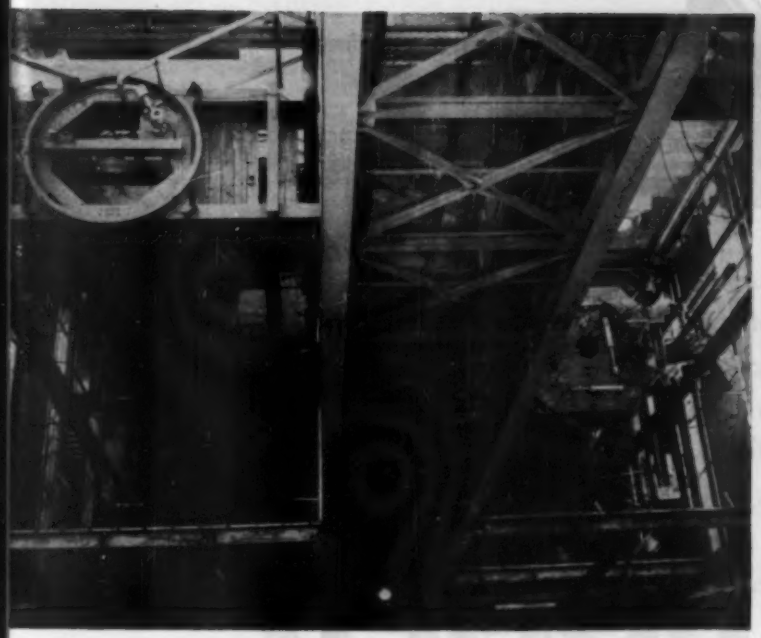
Following fabrication, the tanks are subjected to pneumatic pressure tests. After this the tanks, as well as the one-piece tank domes, are sprayed completely for leaks check. The tank is then taken to a hydrostatic test laboratory where it is placed in the vertical position. It then is cleaned and pressurized by a water fill while closed circuit TV cameras monitor the missile's exterior for any bubbles or dribbles as a backstop to the monitoring pressure gages in the control room.

Leaks are repaired on the spot, and the tank is retested until specifications are met. Hydrostatic test facilities are capable of 5,500 psi. Following successful completion of the tests, the tank is sent back to factory to be incorporated into a Titan prior to continuing tests.

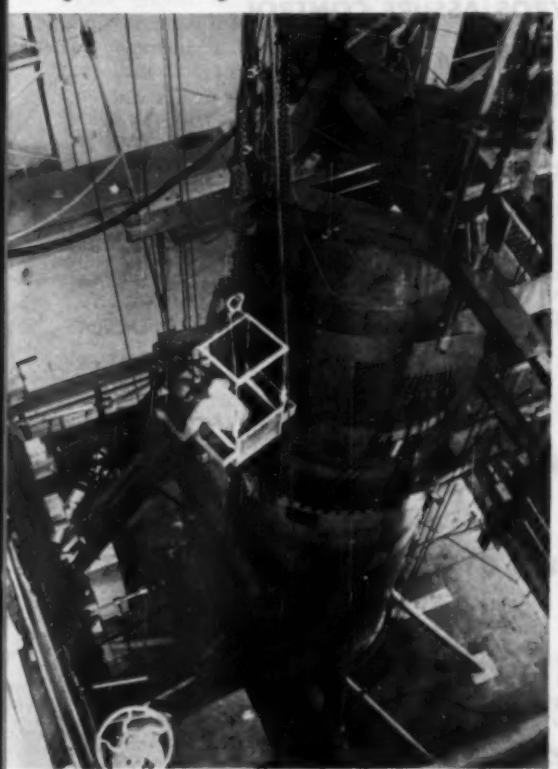
At the same time, other components are being put through the entire gamut of testing: altitude, heat, cold, vibration, wind, function, performance under normal load and over load, and combinations of any or all possible conditions.

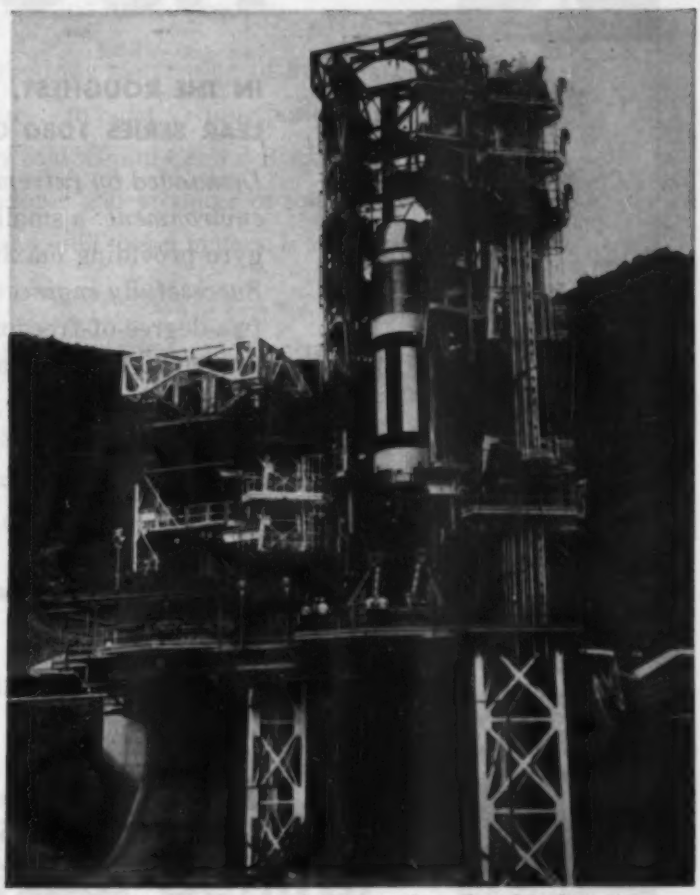
The majority of these tests are conducted on components through the facilities of the nine associate and/or 75 major subcontractors, plus thousands of suppliers and vendors. In addition, special testing laboratories handle particularly difficult work, such as Beech Aircraft, which does a portion of the intricate high-flow cryogenics work. This work includes operating each valve in the oxidizer system using either liquid hydrogen or liquid oxygen at −300F. During this operation, vibration and other flight conditions are also fed into the test.

These and all similar first-level com-



STRUCTURAL TESTS are performed in Martin-Denver Vertical Test Facility (left), which has nine test cells. Missile at left in VTF has pipe (top) through which lead shot is poured to simulate fuel flow. Quartz lamp sleeve (right photo) simulates in-flight friction heating.





IN STRUCTURAL TEST (left) hydraulic cylinder pushes up into Titan, simulating thrust, and lead shot pours down through tanks to simulate effect of acceleration on fuel flow. Titan first stage is lowered (right) toward A-frame that supports it during static firing. Note the two Aerojet-General engines with skirt removed. Second stage is not mated to first stage until first stage is in place on stand. This stand has flame deflectors; stands at Cape Canaveral have flame buckets. Otherwise stands are identical.

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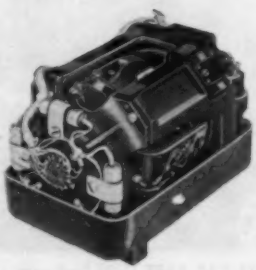

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ponent tests are run to a set of standards set forth either in military or weapon system specifications.

Approximately half the individual component testing and PET is conducted at Denver. Of approximately 500 major Titan components, some 185 are tested at facilities of the suppliers before going to the PET laboratory at Martin-Denver.

Rather than random testing, every item on a selected list undergoes the PET, which is run so that useful life of the component or subassembly is not reduced.

PET laboratory facilities include chambers for single and multiple environments. These include altitude, heat, rain and dust simultaneously, along with shake tables, a centrifuge, and heat chambers. Laboratory capabilities include 250,000 ft. altitude, temperature range of −120 to +450F, and 20 to 95% humidity.

Packing System

U. S. Bureau of Standards worked out the system of testing and packing the large temperature probes carried by Titan with Titan test engineers.

Propulsion laboratory, formerly called the cold flow laboratory, tests everything connected with propulsion and rocket engine itself. The laboratory setups reproduce propellant tankage and plumbing, and real or simulated propellants are run through to prove conditions. Two of the nine complete facilities of the propulsion laboratory are "pencil tanks," which are smaller versions of the actual tankage and plumbing configurations of the Titan and were used to confirm the configuration design early in the program.

Rocket engines for both Titan stages are made, test-fired and accepted by the Air Force at the Sacramento plant of Aerojet-General, prior to shipping to Denver.

At Denver, engines are tested using the actual ground support equipment (GSE), which will support the missile in field operational use. Hydraulic, electronic, electrical instrumentation and plumbing systems are checked, while a recording is made during tests of all valve opening and closing times, also, the "continuity" of the engines using pneumatic pressure, then RP-1 and liquid nitrogen.

After each component or subsystem has passed all tests, it goes to the factory to become part of a missile, accompanied by a complete manufacturing and test history.

Missile stages then are placed on transtainers which will stay with the Titan until the missile is erected on the launch pad. After this, the missile goes on to a 13-story building known as the vertical test facility (VTF), which

THE GRAND CENTRAL REPORT

Tennessee Gas Transmission Company and Food Machinery and Chemical Corporation, the parent companies of Grand Central Rocket, have extensive investments in the energy field. In addition to their interest in Grand Central, TGT is in the oil, gas, and petrochemical fields, while FMC has three other divisions in dimazine, peroxygen chemical and boron propellants as well as other fuel and related products.

It is the long-range plan of both parent companies to build a strong position in the energy field. Grand Central Rocket Co., as a developer and producer of solid propellants and solid rocket motors, is a vital part of this plan.

It is our goal to make Grand Central Rocket, under new and aggressive management and with the addition of major facilities, one of the strongest and most capable solid propellant rocket organizations in the country.

J. J. King

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Chairman of the Board
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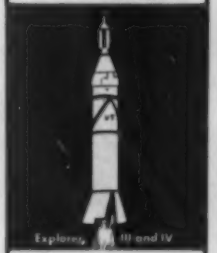
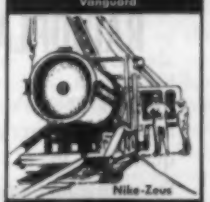
The Dart


Explorer III and IV

Far Side

Vanguard


Nike-Zeus

Test Sled

...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

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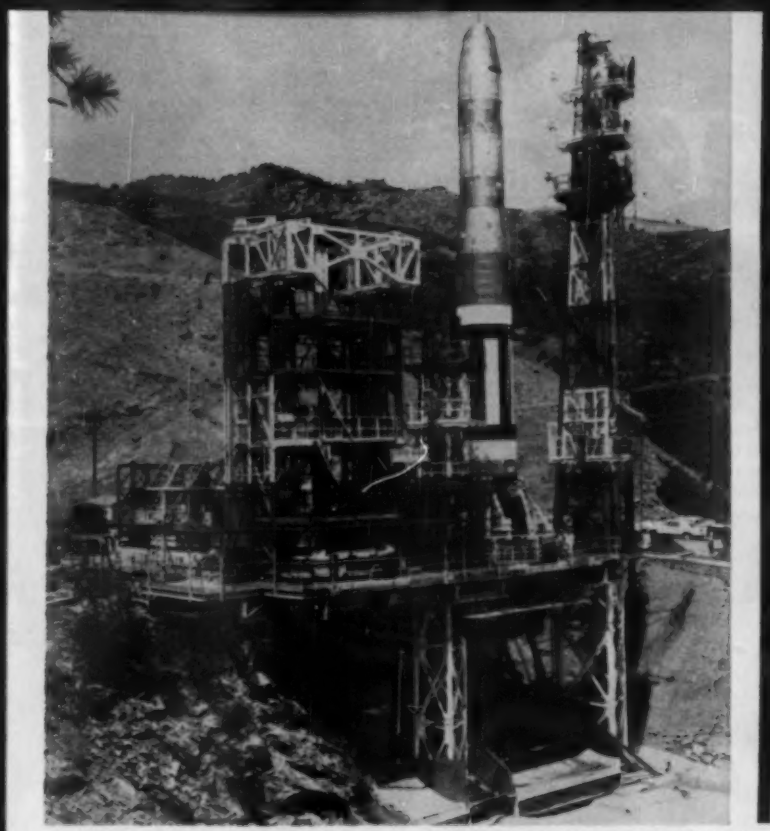


TITAN is prepared (left) for night compatibility firing at the Martin Co.'s Denver facility. At right the vehicle vents liquid oxygen just prior to firing. The test stand differs from an operational pad only in that there are no explosive bolts on stand to release missile.

has no known parallel, according to BMD.

The VTF contains nine cells in which the missile stands vertically and undergoes a variety of tests. Of these, seven cells are closed.

In addition, there are two open cells which are equipped with gantry setups and have steel members which can place one or both Titan stages in any desired position. The open cells are used for engineering structural and destruction tests.

In the closed cells, working platforms such as are used on Atlas gantries, are installed at various levels. When Titan enters VTF, it is picked up by an overhead crane, and placed in the cell for test series.

Open Cell Tests

In the open cells, missiles are tested to destruction. Instrumentation includes such things as strain gages, which record the missile's reactions as stresses and strains of all possible flight conditions are applied.

Titan is loaded by means of steel cables, and side jacks, while tanks are loaded with liquid nitrogen, to be drained at flight rates during the tests. Quartz lamps surround the missile to simulate aerodynamic heating.

In the test program here, everything is applied at once, some conditions varying constantly in simulation of the constantly changing flight conditions, varying attitudes and altitudes of the missile during its flight. Majority of the data gained gives a highly accurate prediction of actual flight behavior.

In two of the closed cells, engineering tests are run on hydraulic and associated systems, gathering complete information for structures requirements, design considerations and functional analyses.

In another closed cell, the missile is loaded with simulated propellants for structural feedback studies. Also in this cell, electrical and electronic systems are measured for feedback, along with stresses and strains that will apply to the black boxes during flight. The area is shielded against extraneous inputs such as radio-electronic interference, so that test readings are as valid as it is possible to obtain.

In the remaining four closed cells, missiles undergo exhaustive physical examination. In this, some 500 separate sensors are used on various points of the missile, which will be used to get verified readings on every possible parameter which occurs in missile flight. Equipment includes a complete set of GSE, functionally identical to the gear used at operational sites, differing only in length of the cables. Only equipment lacking are the propellant loading and engine ignition systems.

Equipments are spread over six levels here. Top bay, the sixth, near the missile nose, is the guidance bay, where tests are run on flight control, guidance and the range safety system. Next bay down, the fifth, is for telemetry, additional safety testing and power output units. Some 300 measurements are read out of this area, which is located around the middle of the second stage.

Fourth bay is with the second stage engine, and checks hydraulic and electrical power. It also functions in conducting a simulated countdown which is part of the vertical test.

Testing Signals Checked

Next bay is located near top of the first stage, where testing signals are simulated and checked. A classified bay separates the third and first bays. First bay is at the bottom where the first stage rocket engine is located. This area has tests on hydraulic pressurization controls as well as engines.

To eliminate any contamination and maintain all possible cleanliness, the main engine is under slight but constant internal pressure which is applied by and controlled from a blockhouse console which is part of the standard ground support equipment.

After an incoming Titan is erected in VTF, electrical busses are checked

GENERAL ELECTRIC T58 MEANS . . .

Top mission capability for Navy's newest subhunter

Twin General Electric T58 Engines Give Sikorsky HSS-2 Increased Payload, Cruising Speed and Endurance

Sikorsky's HSS-2—newest Navy ASW helicopter weapons system—will rely on the proven performance and reliability of its twin General Electric T58 engines to get it to the search area faster—keep it there longer.

The T58's reliability has been proven by more than two years of flight test time on a modified HSS-1. As a result of this unmatched twin-turbine flight experience, here's the kind of engine response the HSS-2 will get whenever it demands the large load changes required on ASW missions:

RAPID POWER RESPONSE—T58's load burst acceleration time from autorotation to 100% military power is consistently three seconds or less.

EXCELLENT CONTROL STABILITY—Flight tests have confirmed the ability of the T58 and its control to adapt to the dynamics of the helicopter rotor system.

EFFECTIVE LOAD-SHARING—Time and again, multi-T58 installations have demonstrated their automatic response to all types of operation transients—their ability to satisfactorily maintain load division between engines.

This proven-in-flight reliability is only part of the T58 story. Results of the T58-6's 150-hour Model Test reflect the engine's high power-to-weight ratio and low specific fuel consumption.

OUTPUT GUARANTEES EXCEEDED BY 70 SHP—T58-6 produced as high as 1120 shp.

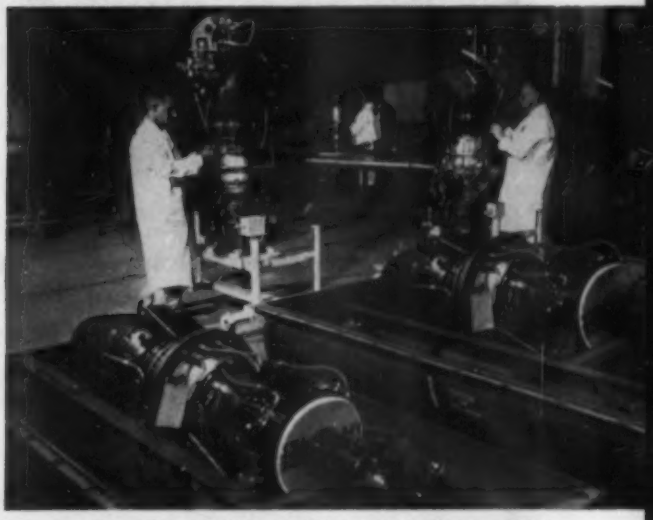
SFC GUARANTEES BETTERED BY 4%—Guaranteed at 0.64 lb/hp-hr . . . SFC was recorded at 0.61.

15 LBS LIGHTER THAN SPECIFICATION—T58-6 weighed just 256 pounds, compared to specified 271 pounds.

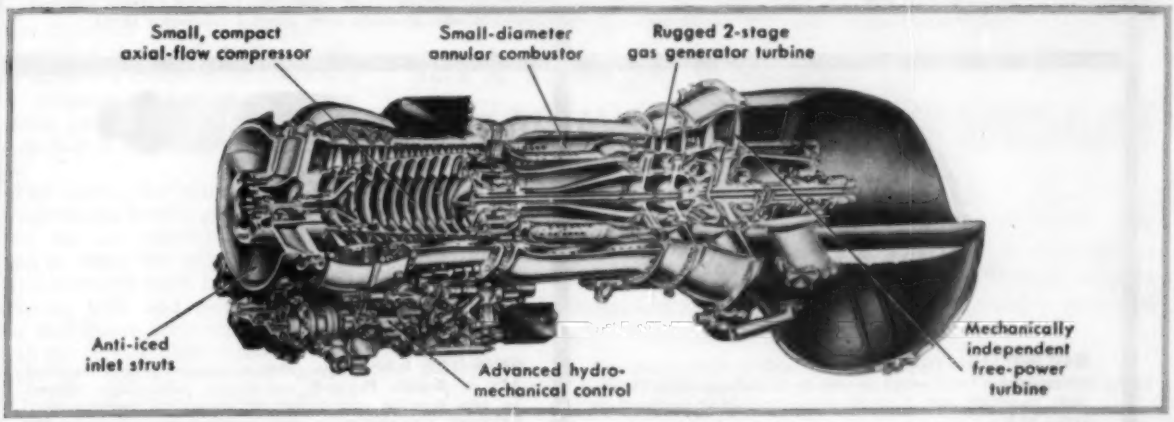
Add this outstanding performance to the T58's demonstrated reliability, and you see why the HSS-2 is expected to be the Navy's number 1 subhunting helicopter.

For the latest T58 progress report, write to General Electric Co., Section GED-3841, Schenectady 5, N. Y. 233-20

Sikorsky's successful S-62 has already demonstrated flying boat hull feature. Its prototype T58 (50-hour) engine logged a total of 393 hours without overhaul . . . including extensive flight-time during U.S. and Canadian demonstrations.



Latest configuration of shipment T58's is bettering specified performance . . . averaging more than 50 shp above guarantees . . . giving improved SFC.



New T58-6, now in production, is similar to original T58 model. Installation features have been added to meet the varied requirements of helicopter and non-helicopter applications.

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engine's high power-to-weight ratio and GED-3841, Schenectady 5, N. Y. 233-20

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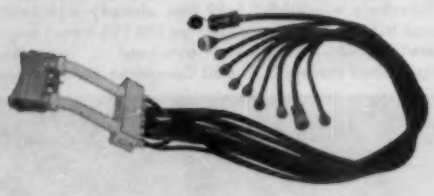
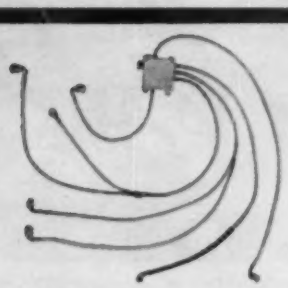


MISSILE CONTROL CABLE: This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.

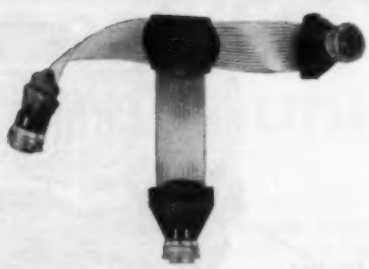
THERMOCOUPLE HARNESS: Flexible, completely sealed and suitable for continuous operation in ambient temperatures of —65°F to 1500°F. Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.



CONTROL HARNESS: This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.

FUEL CELL CABLE: Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.

HEAVY DUTY CABLE: Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



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for ground loops and other minor malfunctions, followed by a check of tankage and pressure systems, including all valves, regulators, indicators and all moving parts.

Next, the entire propulsion system is checked short of actual propellant loading and ignition. After this, the control system gets a complete workout, using blockhouse-type GSE, including the input-output, hydraulics, servomechanisms, internal missile programing, plus all associated functions.

Guidance Check

When the guidance system is interconnected to Titan, the unit is checked. Missile telemetry is tested next, during which the missile's antenna will actually send signals to ground station receivers. After this, a timed countdown is run, simulating all functions of the missile, including simulated engine operations while reactions are checked.

Simulation is done here by an operation very close to that of an analog computer, as it recreates an electrical reproduction of the system, then measures, proves, and evaluates the system.

After countdown, data is reduced. All data then is studied and reviewed by a team of representatives from USAF and Titan associate contractors.

One specific test objective is to keep the components "new" and unaffected by testing, so a damage check for any minor random injuries is conducted during missile evaluation. If the Titan passes the evaluation following data reduction, it is brought here by the Air Force.

Captive Test Stand

The missile then is taken to the captive test stand at Denver, its last stop at the factory prior to going to Cape Canaveral and its launching. Accompanying the missile to the captive test stand is a complete log containing the individual history of every component, plus a second log which covers the history of the complete missile as a unit.

The captive test stand differs from an operational launch pad only in that there are no explosive bolts in the stand to release the missile. Otherwise it is a complete flight type installation, including GSE and procedures. It is here that launch crews are first trained.

At the captive flight stand, all tests which are not accomplished in the VTF are run, prior to conducting the missile compatibility firing (MCF), the last test before flight.

After the missile is erected, the pre-MCF tests start with guidance and control checkout. Standard GSE is used throughout; tests can be conducted entirely from blockhouse. Propulsion is worked over at the same time, including full pressurization checks with both

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liquid nitrogen and liquid oxygen. Electrical, electronic and missile safety systems are checked under test conditions. Still more tests are conducted on the mechanical parts, missile handling features, erector, accessory, water and fire fighting systems, and procedures.

In the blockhouse, a test engineer runs checks on the missile's internal flight programer. Through his console, he feeds a set of simulated conditions to the programer, which is "fooled" into thinking these are flight conditions and sends back a report of its responses. The machine, which is part of the GSE test console, integrates all the figures received back from the programer for the final output figure.

Digital Readout

Visual digital readout display on the engineer's console gives a final score. This numerical value indicates whether the missile is operating properly, and must be within a certain band.

In addition to pretesting and MCF of flight articles, these stands run two other basic types of tests, using battleship stands and missile captive test units. The missile captive tests are those used for product improvement, in which missiles are subjected to many conditions spelled out in specifications, also many conditions far beyond the specifications—extra stress and loads, unusual delays in countdown, cold soaking, and induced errors. Results gleaned from these tests on captive missiles contribute to over-all flight test program speed and success.

Battleship tankage test stands allow tests of the propulsion system to be made without consideration for tanks. In these, capabilities of propulsion and a major part of flight control hydraulic servo and support GSE systems can be made. Both stages of the missile have been fired in flight sequence using the battleship setups.

Titan Test Plan

Each unit of Titan has a test plan, a set of general test directions as compiled by all personnel involved. This test plan is written into the test conductor's countdown, and is the operating document for the missile compatibility firing. This record is the final test document at Denver, and contains the check list for MCF, which is the missile's last workout at Denver.

MCF yields roughly 225 measurements and separate bodies of test data. The complete Titan weapon system functions as nearly as possible as it would as if the missile were airborne. Quick-look data is available eight hours after firing, although the blockhouse personnel usually know how the firing went as soon as it is concluded.

Following MCF, missile stages are taken on transtainers to Lowry AFB,

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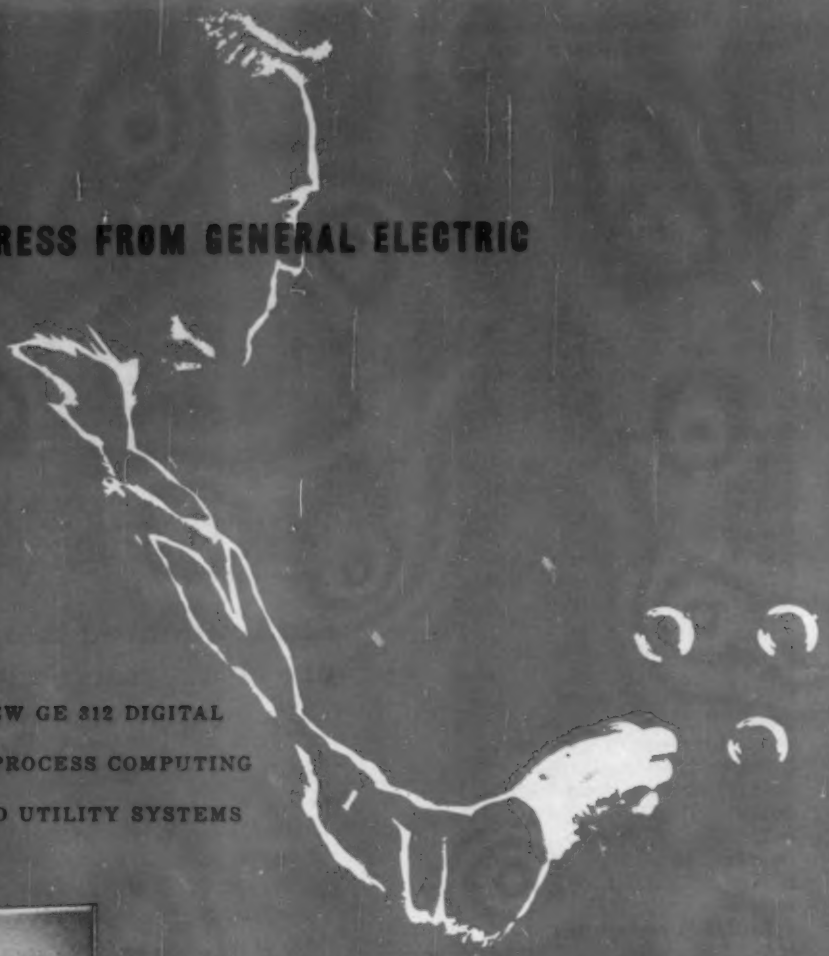

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CPA-16 (5-59)

and airlifted to Cape Canaveral. At the Cape, because of the comprehensive test program and speed of airlift, the missile requires little or no work other than that normally involved in readying the missile for flight test.

Demonstrating this, a newly experienced and minor malfunction occurred during a Titan launch attempt at Cape Canaveral. AFMTC technicians called the missile test laboratory at Denver, and by noon the next day the launch was simulated at Denver and conditions were duplicated exactly and a firing was attempted. The same malfunction occurred. By that night, an answer had been worked out, and new data was transmitted to the crews at the Cape. Less than 48 hr. later, a total of three days after the first malfunction, the missile made a successful flight.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command.

Andrea Radio Corp., Long Island City, N. Y., various components of the AN/AIC-10A interphone communication system, end use: supply replenishment spares, (PR's PE-9-16A-4119 and SM-9-16A-2026), $31,692.

Bell & Howell Co., Chicago, Ill., 72 ea., firing error indicator pod sets, spare parts and handbooks for certain unknown aircraft, IFB-33-600-59-129, (MIPR R59-3292-65-NOas and amendment No. 1), $1,064,100.

Cessna Aircraft Co., Wichita, Kans., modification of T-37A trainer aircraft, (PR MA-9-01A-1082), $28,500.

McDonnell Aircraft Corp., St. Louis, Mo., 261 ea., RF-101A/C aircraft retrofit kits and handbooks, (PR PH-7-01A-7488), $1,560,339.

General Precision Laboratories, Pleasantville, N. Y., 62 ea., AM-946/APN-89 amplifiers, electronic control, Aerno. 81-0192, used on B-52G aircraft, (PR's PE-9-16K1-4210 and MD-9-16K1-55153), $100,000.

Wiley Electronics Co., Phoenix, Ariz., flight test of AN/ARR-24 (XH-1), aircraft: none applicable, (PR 64415), $347,283.

Convair Division, General Dynamics Corp., San Diego, Calif., modification of T-29B aircraft for emergency monitoring control, (PR's SA-9-01A-5159 and SA-9-01A-5164 and amendment No. 1), $310,111.

Hughes Aircraft Co., Culver City, Calif., continuation of SAGE integration program, (PR PE-9-11B-4303 and amendment No. 1), $126,000.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., 164 ea., wheel assemblies, 125 ea., axle assemblies, 188 ea., brake assemblies for C-133B aircraft, and applicable spare parts and data, (PR EA-9-03B-4525), $372,154.

Topp Manufacturing Co., Los Angeles, Calif., 10 ea., angle of attack and sideslip sensors in accordance with WADC exhibit WCLCI-1-62, (PR PE-9-05C-4167), $71,362.

Fairchild Camera and Instrument Corp., Syosset, N. Y., 315 ea., CAX-12 70mm camera components, applicable to F8U Navy aircraft, (MIPR R59-3293-65-NOas, complete), $1,636,998.

Aero Instrument Co., Cleveland, Ohio, 9,437 ea., tubes, airspeed, pitot, type AN-5812-1, Aerno. 60-9650 and supply spares, IFB 33-600-59-88(PR MA-9-05C-264), $129,758.

Radio Corporation of America, Los Angeles, Calif., 20 ea., radio receivers; 20 ea., indicators; 143 ea., coupler antennas AN/APN-70 LORAN; end use will be for the Canadian government and the U. S. Coast Guard, (PR EC-16K1-4410 and amendment No. 1), (MIPR CG-43-565B), $104,813.

high-energy fuel briefs from Callery

Plenty of HiCal® by August 1, for authorized users—HiCal high-energy fuel production will run well ahead of immediate military test program requirements for the next few months. So Callery will have substantial quantities of HiCal-3 available for authorized users about August 1. If you have been waiting to test HiCal-3 in engines or components, write now for specific information. *New HiCal-3 Handling Bulletin is available on request.*

Lower-cost Diborane from Callery—Production quantities of Diborane are available from Callery at recently reduced prices. Investigations now under way on new process economies will mean even lower prices in the near future.

NASA awards contract to Callery for rocket propellant study—NASA has just announced the Government's first major contract award to Callery Chemical Company for research and development work in the field of rocket propellants. The NASA contract is to determine feasibility of a radically new propellant system.

New HiCal-3 fire-fighting film available for loan—This film shows the relative ease and safety with which a stable mechanical foam blanket can be established over burning HiCal liquid.

Handling of pyrophoric fuels—A new bulletin summarizes safe-handling practices for Triethylborane and Tri-*n*-butylborane. Also available: a 15-minute Triethylborane-Tri-*n*-butylborane fire-fighting film.

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Callery to open new office in Los Angeles—Sometime in June, fuel and propellant users in the Los Angeles area can contact Callery's Dr. R. G. Brault, Market Development Engineer, for helpful technical service. Dr. Brault formerly was coordinator of high-energy fuel projects in Callery's R & D program.

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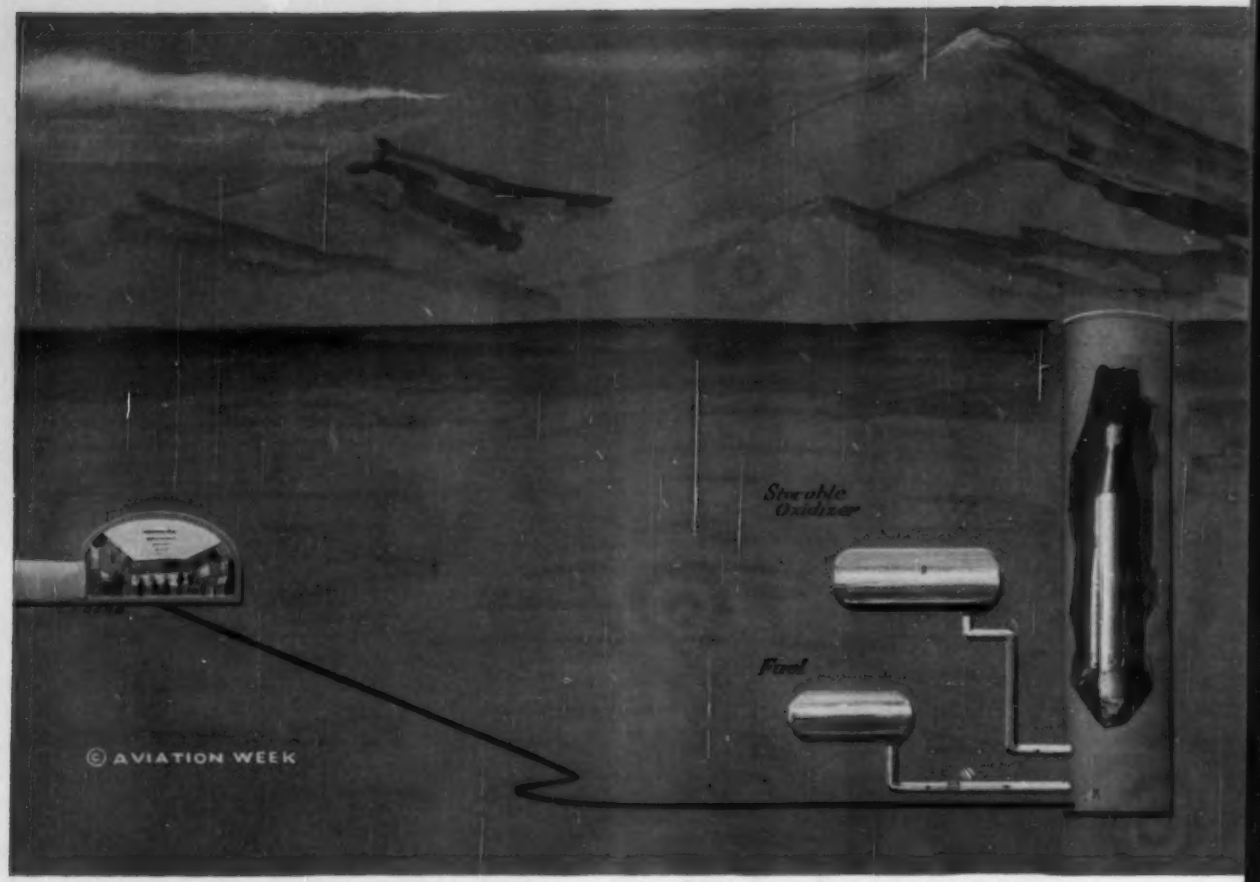


ATLAS ICBM deployed under a unitary concept would have one missile in its launch hole controlled by one blockhouse.

Atlas Ground Support Equipment, Part 1:

Atlas' Flexibility Permits Varied Bases

San Diego—Atlas ICBM weapon system ground support equipment was designed by Convair's Astronautics Division concurrently with the missile to emerge at the right time from the development pipeline, meeting required standards for compatibility, maintainability and reliability.

Flexibility is evidenced by the two Atlas launch complexes at Vandenberg AFB, Calif.; 65-1 utilizes the gantry and other equipment which was a necessary part of the development hardware used at Cape Canaveral, Fla., and 65-2, which uses more streamlined erection methods, stores the missile a different way and is less complicated in over-all operation.

Beyond this 65-2 and similar installations at Warren AFB, Wyo., are the semi-hard sites at Forbes, Kans., and Fairchild, Wash., AFBs, and the "hard" Atlas site which employs a silo in the same manner as Titan ICBM.

An even further jump into the future is Atlas deployed in the unitary concept, which would have Atlas and its greater load-carrying capacity employed in the same manner as Minuteman (AW Jan. 19, p. 68), using storable propellants to eliminate the problems posed by current cryogenic oxidizers.

Under the unitary concept there are two possible methods of launching the missile. One way, the missile would be stored underground, and raised to the surface for firing. The second system would have the Atlas fired from its position down in the storage hole.

Although an Atlas operated from a silo is the furthest along that fairly firm planning has taken the weapon system, there have been numerous studies of Atlas in the unitary concept. Problems associated with the unitary installation for Atlas, both the inherent ones generated in trying to operate any large, liquid-fueled rocket from a remote site, plus new ones, are judged solvable within today's state of the art.

Using Atlas in the unitary concept would have one missile in its launch hole controlled by one blockhouse. This installation would be in a remote site, as is envisioned for Minuteman installation. In this environment, the missile might either have its propellants aboard at all times, or stored in separate tankage from which they could be transferred to the missile in minimum time.

The maintenance cycle under the unitary concept may well differ from today's system. If the missile exists with its propellants aboard, exercising of systems and subsystems would not be the same as if the weapon had no fuel or oxidizer aboard.

Much of the ground support equipment used in operating Atlas from either Vandenberg complex would have to be changed to fit the unitary concept. Primarily, systems checkout and some elements of launch control, which are considerably interlaced in the

launch control center of today's blockhouse, would be broken out, and installed in mobile equipment such as trailers. These would be taken from site to site to perform required maintenance checkouts. This type of work would be accomplished on a time-cycle basis.

War gaming has been conducted under which Atlas is employed in the unitary concept at remote sites.

In these war games, all factors relevant to Atlas usage in this manner are seriously considered. This includes such aspects as over-all economic costs, technical requirements and personnel.

Economic Factor

Since employment of Atlas in a remote site is deemed technically feasible, the most heavily weighted factor in deciding whether or not to use the weapon system on this basis would seem to be economic. The significant parts of the economic consideration would be the cost of adapting existing ground support equipment to match the new philosophy, plus the cost of developing new ground support equipment elements peculiar to the concept as well as logistics involved.

When logistics are considered there not only is the factor of missile parts and components supply, but also facilities for personnel. With current Atlas installations going in close to either active or former Air Force or other military installation sites, a considerable part of the cost of an Atlas site is avoided, in that such things as barracks, administration buildings, post exchanges and similar required facilities for personnel already are available. Choice of these bases with their already existing facilities also is favored by the fact that almost invariably the required access roads, rail heads and similar logistic requirements already are available.

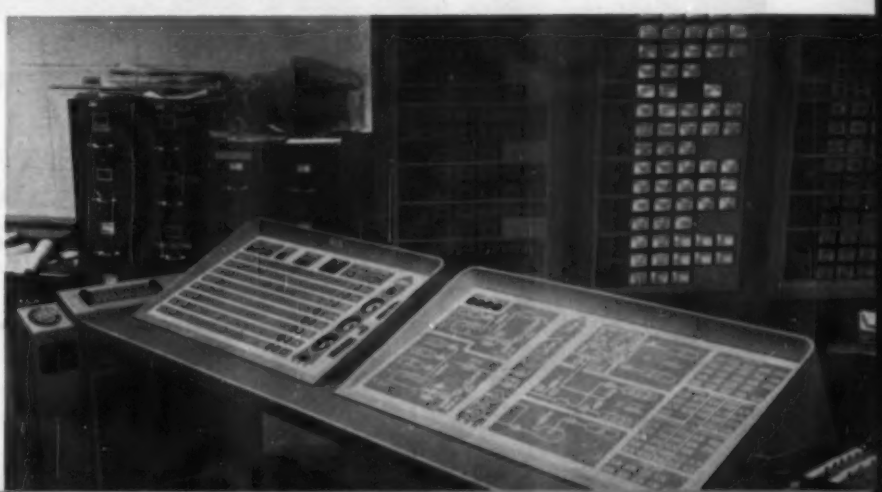
Personnel Accommodations

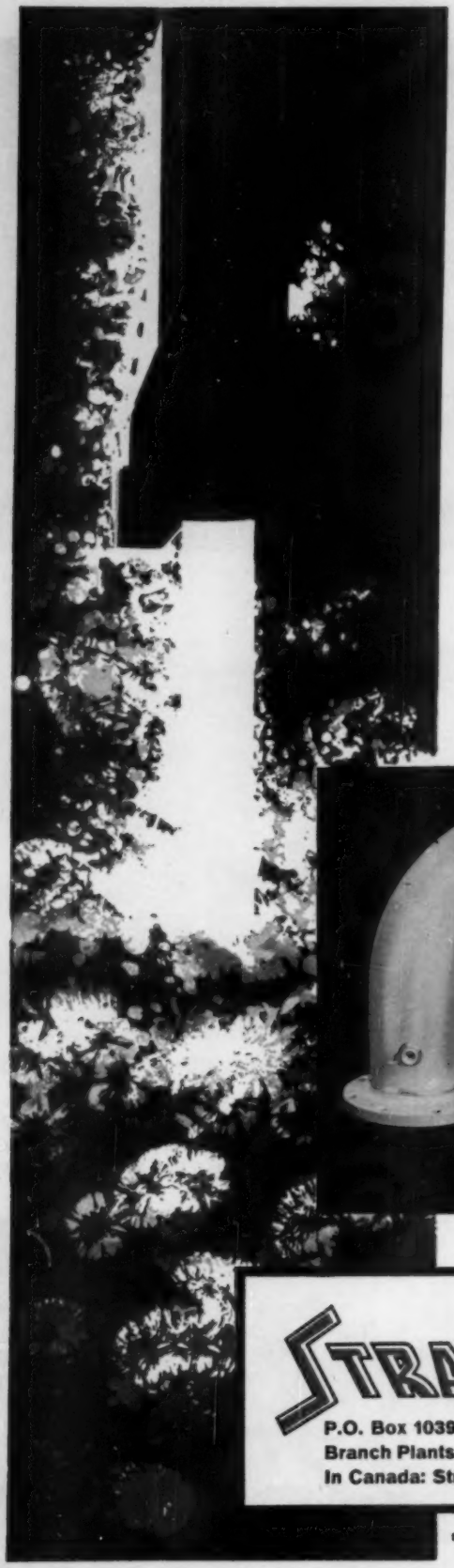
Going to a remote site, to a large measure, requires new installations for personnel and changes in the methods and systems used to supply the missile itself. However, since fewer men are involved per remote missile site, this aspect of facilities is eased somewhat. With perhaps 20 or less men per remote site, quite possibly their living quarters would be underground and a part of the blockhouse complex. The crews could be rotated to and from the remote underground site frequently to ease the morale problem.

Although Atlas in unitary concept is considered technically feasible, it is noted by authorities that there has not been enough research conducted with storable propellants as part of an operational ballistic missile weapon system to ensure that these propellants can be stored in a missile's tanks for any

ATLAS launch complex is shown in artist's conception as it will appear when constructed at Warren AFB, Cheyenne, Wyo. Complex will be similar to 65-2 at Vandenberg AFB.

LIQUID OXYGEN storage tanks have been installed (left, above) at launch and service building under construction at Warren AFB. Launch control center (below) is in interior of blockhouse for 65-1 complex at Vandenburg AFB. Console on left is that of launch control officer; one at right is for analyst. Three panels in background are status panels—one for each of the three pads per blockhouse.





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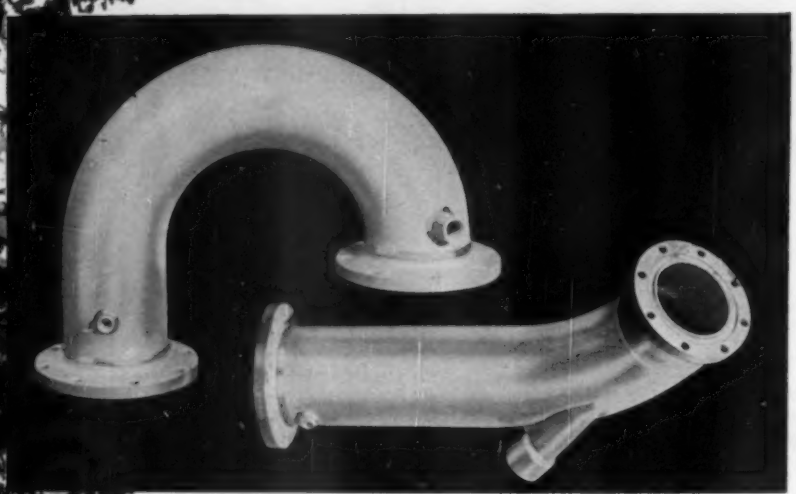

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length of time. While it is realized that materials used throughout would have to be made passive and receive other treatment required to make them able to handle the highly corrosive combinations being considered for storable use, there still remains much work to be done on an extended time period basis.

Opinion is divided on whether these propellants could be stored in the missile tanks. There are those who say theory indicates that it can be done for the time periods involved in Atlas as used in the unitary concept. There also are those who would withhold final opinion until sufficient testing has been conducted to verify the facts.

Systems Flexibility

There is evidence that in general, however, Atlas weapon system elements have been designed and developed with the flexibility required to keep the over-all costs of developing changeover to unitary philosophy low. The propulsion system, for example, could change from current fuels and oxidizers to storable propellants without extensive redesign. Most changes would involve such things as seals, gaskets, regulators and valves. Injector faces, too, would have to be changed. However, it is felt that these propulsion system changes would be closer to being modifications than new designs. This would, of course, be reflected in the over-all development costs.

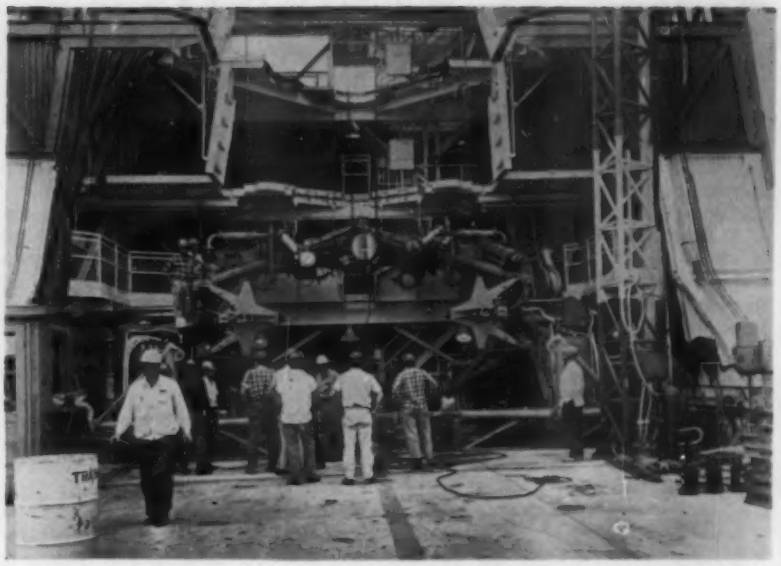
All-inertial guidance system for Atlas, which will be used in such sites as Warren AFB and later installations, would naturally be carried on into the unitary concept.

A further consideration would be whether or not the missile itself could be fired from a hole in the ground. Technical feeling is that this is possible, but a complete investigation of acoustic vibration effects will be required to fully establish operational suitability. A primary development cost in this area, it is felt, would be providing facilities to prove that the missile could be launched from a hole in the ground.

Whether or not acoustics would require redesign or change the missile structure and associated systems in order to launch by this method would depend on the outcome of these critical tests.

Some persons feel that, at worst, problems requiring engineering solution might arise, while others argue that no major changes would be necessary.

Another subject which enters into the gaming exercise is that of over-all costs of a weapon system in relationship to the targets against which it is to be used. There is much to be said concerning under-killing and over-killing a target; that is, whether future warhead weights and yields which Atlas is capable of carrying over and above the weight and yield of today's warhead are worth the effort.



ATLAS LAUNCHER at Cape Canaveral, Fla., is rotated into position to accept a missile.

These must be plotted against the presently envisioned warhead weight and yield for Minuteman, the basic "bird in a hole." Consideration must be given to the growth potential for warheads which Minuteman undoubtedly contains; that is, its possible later use with a heavier weight, higher yield warhead or a cluster of warheads which would be dispersed from an altitude high enough to allow them to travel to several targets, not overlapping each other too much, if at all, in the kill area.

Equipment Changes

Although there is a great degree of progression from the research and development type support facilities and hardware in the Atlas ground support equipment from that used orginally at Cape Canaveral, to that used at Vandenberg 65-1 and 65-2 complexes, and on to the sites at Warren, Fairchild and Forbes AFBs, much of the ground support equipment involved has remained relatively unchanged. Changes have been evolutionary, rather than revolutionary.

The changes which have occurred have been primarily design refinements, incorporating lessons learned as the missile and other elements progressed from the first research and development firings at Cape Canaveral toward the first operational capability at Vandenberg. While many sections of the ground support equipment at Cape Canaveral were there primarily due to the research and development mission, much of this same equipment is still present at Vandenberg. Many elements of ground support equipment are required for both the research and development effort as well as the operational and training mission.

Many parts of the missile must receive the same preflight (countdown) attention whether the missile is at a research and development site or an operational one.

At the 65-1 complex at Vandenberg, similarities exist to the Cape Canaveral installation in that this Vandenberg complex will first conduct training missions.

Due to the training mission, a degree of instrumentation peculiar to this mission is required and is retained in the Vandenberg 65-1 installation. However, the 65-2 complex which is primarily an operational installation, eliminates much of this training-required instrumentation.

Design Refinements

Ground support equipment changes in this progression have been primarily refining the design to meet the operational needs. Elementary equipment is still basically the same. As an example, the launcher frame remains almost the same at Cape Canaveral, Vandenberg 65-1 and Vandenberg 65-2, but there have been design refinements made from one installation to the next.

Probably the largest change so far along the line was the switch between 65-1 and 65-2 at Vandenberg, in the elimination of the gantry type missile erection system and substitution of the new erector system.

Additional changes in ground support equipment, due to operational philosophy progression, have occurred at Fairchild and Forbes AFBs, where the sites are hardened to withstand 25

psi. over-pressure from nuclear warhead explosions.

At these sites, the missile is stored in the horizontal position as it is at Vandenberg 65-2 complex, also at Warren AFB and Offutt AFB. Here, the missile is protected from weather with a set of doors which closes over the missile at rest, and rolls back when the missile is to be erected.

At Fairchild and Forbes, the missile is stored in the horizontal position, but in addition, is contained in a coffin-like structure which is able to withstand the required 25 psi. over-pressure.

Additionally, while at Vandenberg 65-2, Warren and Offutt the launch and service building from which Atlas is launched is primarily above the surface, the launch pad itself is above ground about one story, with a long ramp for towing the missile up to the launcher on its trailer.

Erector Ramp

At Fairchild and Forbes, even this part of the missile launch/service building will be semi-underground; that is, the ramp to the erector will be a downgrade. A section is dug out behind the building for exhaust emerging from the deflector bucket. Banked earth protects the ramp and rest of the launch/service building structure.

At Vandenberg, a third Atlas complex is scheduled soon. It will have a configuration like the Forbes and Fairchild Atlas sites. Thus, the Vandenberg facilities will give Strategic Air Command operational crews training on whatever configuration will be used at the operational base to which they are assigned.

Generally, the Vandenberg, Warren and Offutt bases are classified as "soft," while Forbes and Fairchild are "hardened." Actually, the question is—"How hard is hard?" The basic classification today would seem to be that "hard" is at least able to take 100 psi. over-pressure.

Missile launch control and systems checkout equipment has changed very little from the Cape Canaveral to Vandenberg to Warren installations. A more elaborate set of checkout equipment is required at Cape Canaveral, since many systems must be verified for instrumentation as well as operation. At Vandenberg 65-1, this equipment is only as sophisticated as it needs to be for the training mission. In the 65-2 site, the complexities and extra frills generated by the requirements for instrumentation for R&D work and training have been all but eliminated. What remains here is primarily that required to launch the missile for a war-type flight.

Atlas ground support equipment for current operational concepts falls into six main categories, although some are interrelated by their functions as parts of the weapon system. Categories are:

- **Launch control equipment.**
- **Systems checkout equipment.**
- **Handling equipment.**
- **Maintenance equipment.**
- **Facilities.**
- **Ground guidance station** and equipment.

Design requirements for Atlas ground support equipment are based on two prime criteria: reliability and maintaining the missile in operational readiness condition. They have tended to result in much automatic equipment which average user personnel in Strategic Air Command can work on a go, no-go basis.

Launch control and systems checkout equipment were designed for Atlas under subcontract from Convair Astronautics. The two are separate categories but are closely intertwined by the part each plays in the countdown, in keeping the missile fit to fly quickly on a day-to-day basis, and incorporation of both on an integrated basis in the heart of the blockhouse, the launch control center.

Actually, Atlas launch control system performs its own plus much of the checkout function, it being the master of the two. The checkout is required in the launch control to a certain degree, and has the additional capability of providing greater detail on the missile's systems when it is used as part of the periodic check of the vehicle to ascertain what and how much maintenance is required.

Control Equipment

Launch control equipment is of two basic natures: mechanical and electronic. Mechanical equipment is that which actually services the missile, such as pressurization and hydraulics, while electronic is that which controls and monitors the mechanical elements.

An essential parameter in launch control system design is time, and while minimum time is important, it is not all-important.

PRE-PUNCHED cards are fed into checkout unit which interrogates Atlas and reports whether or not missile is ready to be fired.

Such aspects as successful completion of the planned mission versus substitution of a secondary target must be considered in light of existing circumstances. One question which arises: If a missile is able to receive only three-fourths of the propellant load required for the given mission due to some malfunction, is it better to abort the missile and reorient the launch control center to another missile, or shoot at a closer secondary target with the less than optimum missile?

Launch control equipment is required to have the flexibility which allows such decisions to be made with minimum time penalty.

Systems checkout equipment acts to energize various ground and airborne systems of the missile. It interrogates them and gets an answer which has to be within tolerance or a no-go signal is flashed. It also acts to check the launch control system and its associated circuitry.

Programed Approach

Systems checkout utilizes an automatically programed approach, with a deck of punched cards fed through to control activation of various systems and provide limits within which operations must fall to allow sequences to continue or be halted.

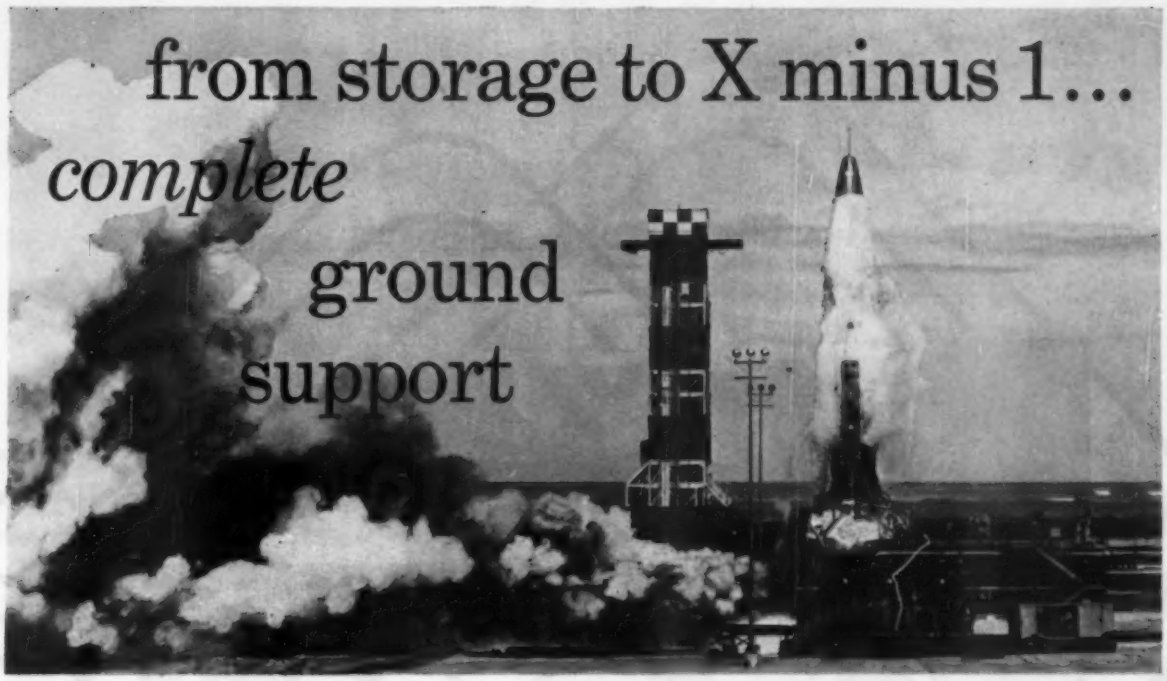
In addition to the missile's various ground and air systems, the launch control system and its associated circuitry also are checked. On top of this, the unit also operates in a self check mode, which usually is employed before and after a launch.

The checkout system indicates, in many cases of malfunction, not only the specific location but magnitude as well. The system covers the warhead and associated equipment in the reentry vehicle (nose cone). Unit determines if maintenance must be accomplished in the launch control center of the blockhouse, status panels tell the missile story, ranging from no-missile-on-the-pad to missile-ready-to-launch.

Two rows of consoles, human-engineered to an extremely high degree, are used in the checkout-launch operations, both in research and development flight testing at Cape Canaveral and at Vandenberg AFB for the training mission.

One row has the facilities console, from where an operator controls television cameras which monitor the launch pad from a variety of angles. The unit also monitors the fire extinguishing systems, main power sources and other parts of the facilities related to launch operations. Facilities console serves all the launch pads controlled from one blockhouse, and is switched from pad to pad according to which one is operating.

Launch operator and analyst's con-



CEC's design capabilities and facilities for developing and producing complete missile ground support equipment is a matter of record. Typical of CEC's ground support equipment are static and dynamic checkout units for fuel systems . . . propellant utilization exerciser systems...and electronic systems for telemetry, inertial guidance, and control checkout. For full information, send for CEC Bulletin 3017-X5.

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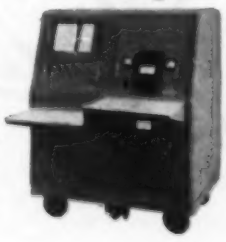
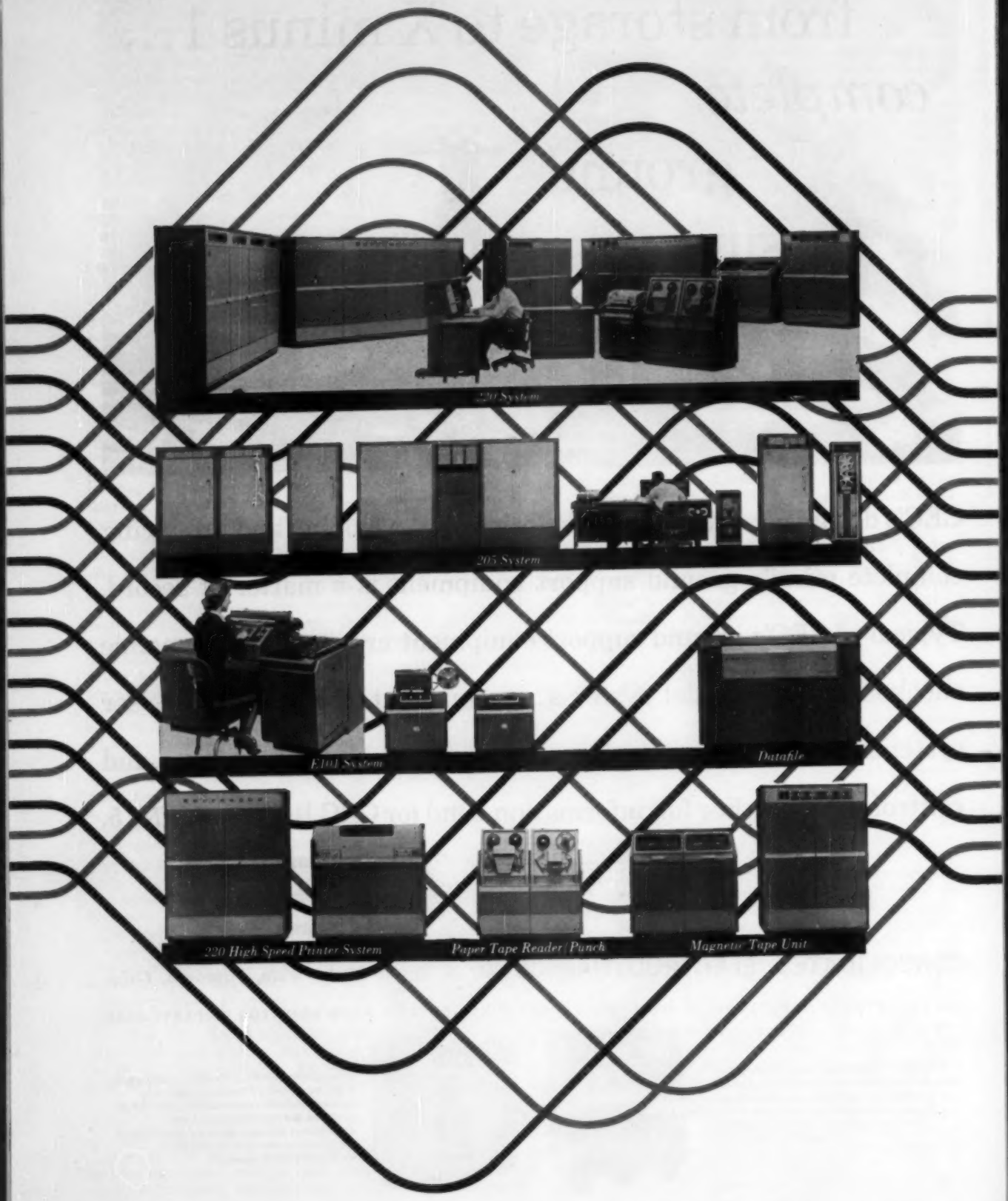


Pneumatic Checkout System is essentially a go, no-go device that automatically pressurizes and tests missile pneumatic systems during storage and pre-countdown periods. Sensing units detect any malfunction, transmit signals to automatic comparator.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soles are the second row, and are two-panel consoles, requiring one operator for each console. Additionally, one console is required for each pad controlled by the blockhouse.

Launch operator starts missile's systems in sequences with pushbuttons, while colored lights constantly inform him of the status of the various systems, i.e., what stage of progress has been reached, if a failure has occurred or if successful completion of sequence has occurred. The panel for the launch analyst is an animated diagram of the missile's major systems plus indicator lights to show status.

During the countdown for an Atlas launch, there are stop-and-wait points in case small malfunctions occur. There also are stop and re-do points if a problem arises which can be fixed with the missile still on the pad.

When a hold is indicated on the analyst's panel, he can diagnose the problem. Decision to hold for a fix, abort, or go on a calculated risk basis is made by the launch control officer, on the basis of the problem diagnosis of the analyst.

Panel design human-engineering involved finding a balance point between automation and human control, with both sides having points to make in their favor. Resulting units have taken advantage of such ideas as using only pushbutton switches, a "one way only" idea, with no toggle switches that present the possibility of their being moved in the wrong direction.

Use of Color

Much use is made of color in designating systems status, and colors were chosen which even allow the operator to suffer from a mild degree of color blindness without endangering the overall system operational effectiveness.

Desired reliability has led to use of relays which are large and strong and which are only beginning to become broken-in after a million cycles. The only vacuum tubes used anywhere in the systems are those of the television monitors, which are not essential to completion of an operational mission.

(This is the first of two articles on Atlas ICBM weapon system ground support equipment. The second article will appear in next week's issue.)

Hallamore Will Modify 11 Atlas Test Trailers

Hallamore Electronics Division of The Siegler Corp., Los Angeles, will modify 11 of its Atlas ICBM test trailers under a contract of approximately $500,000. Modification work on the 40 ft. trailers includes installation of new equipment to check out, monitor and analyze telemetered data from the latest version of the Atlas.

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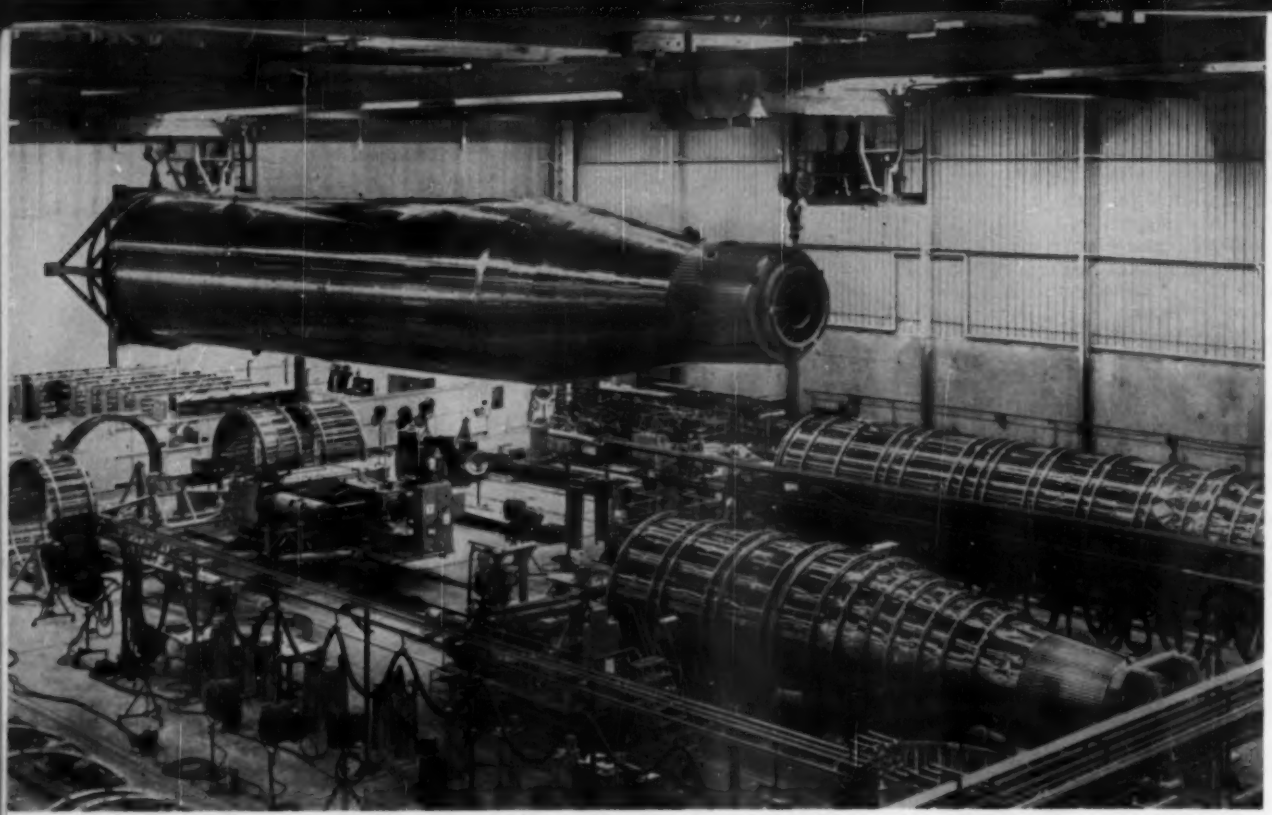
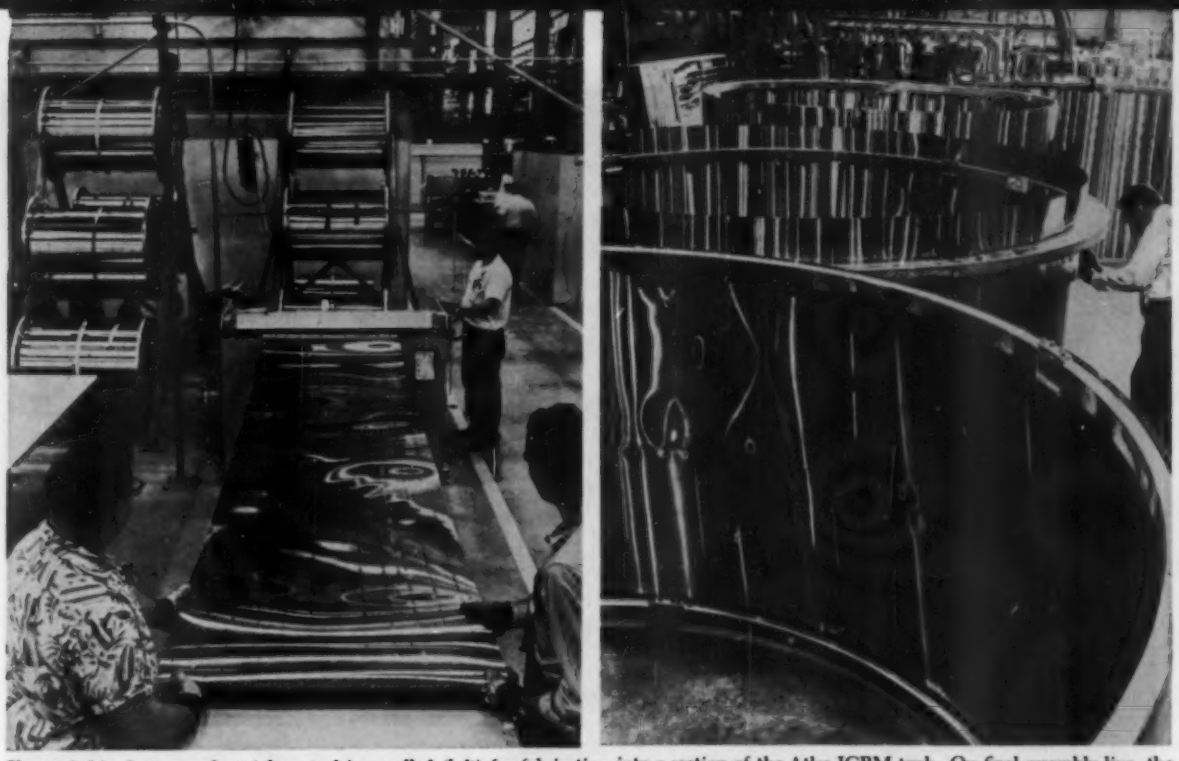
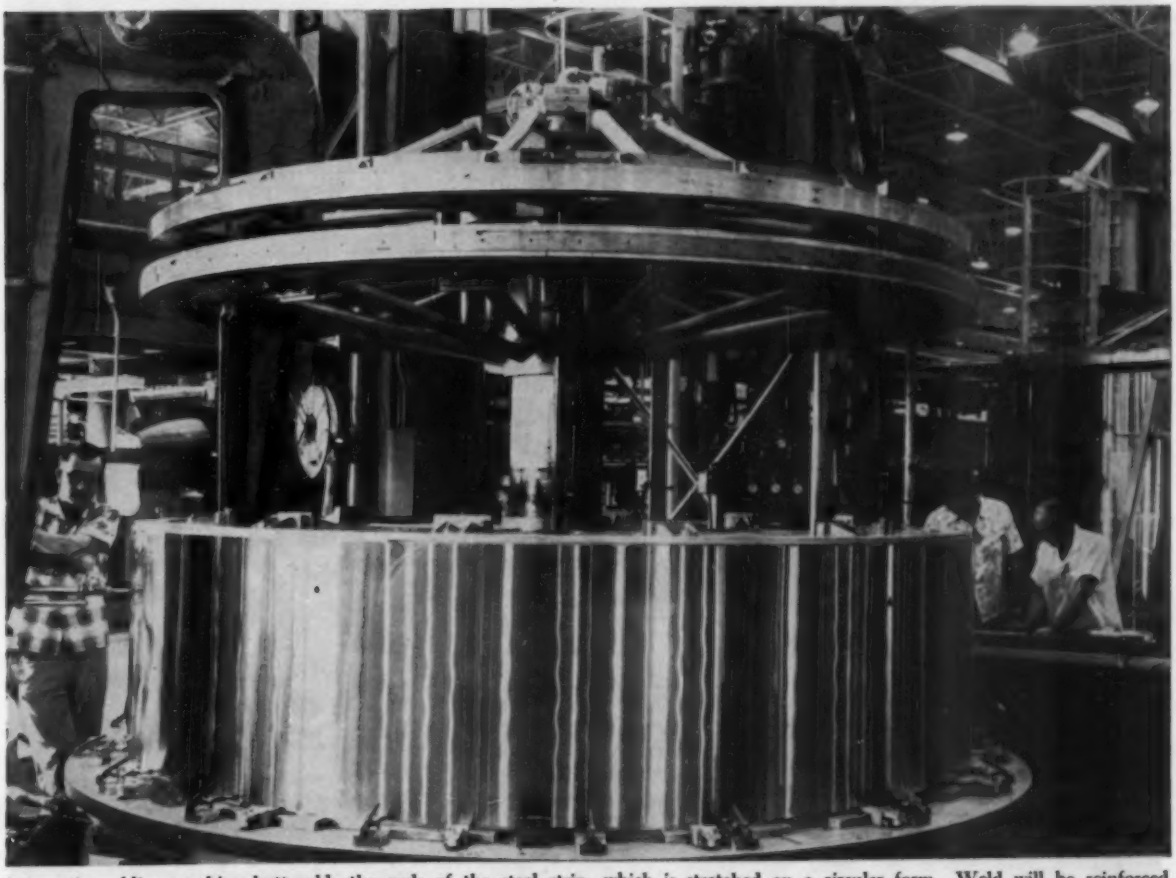


Convair-Astronautics Fabricates Atlas Pressurized Fuel Tankage

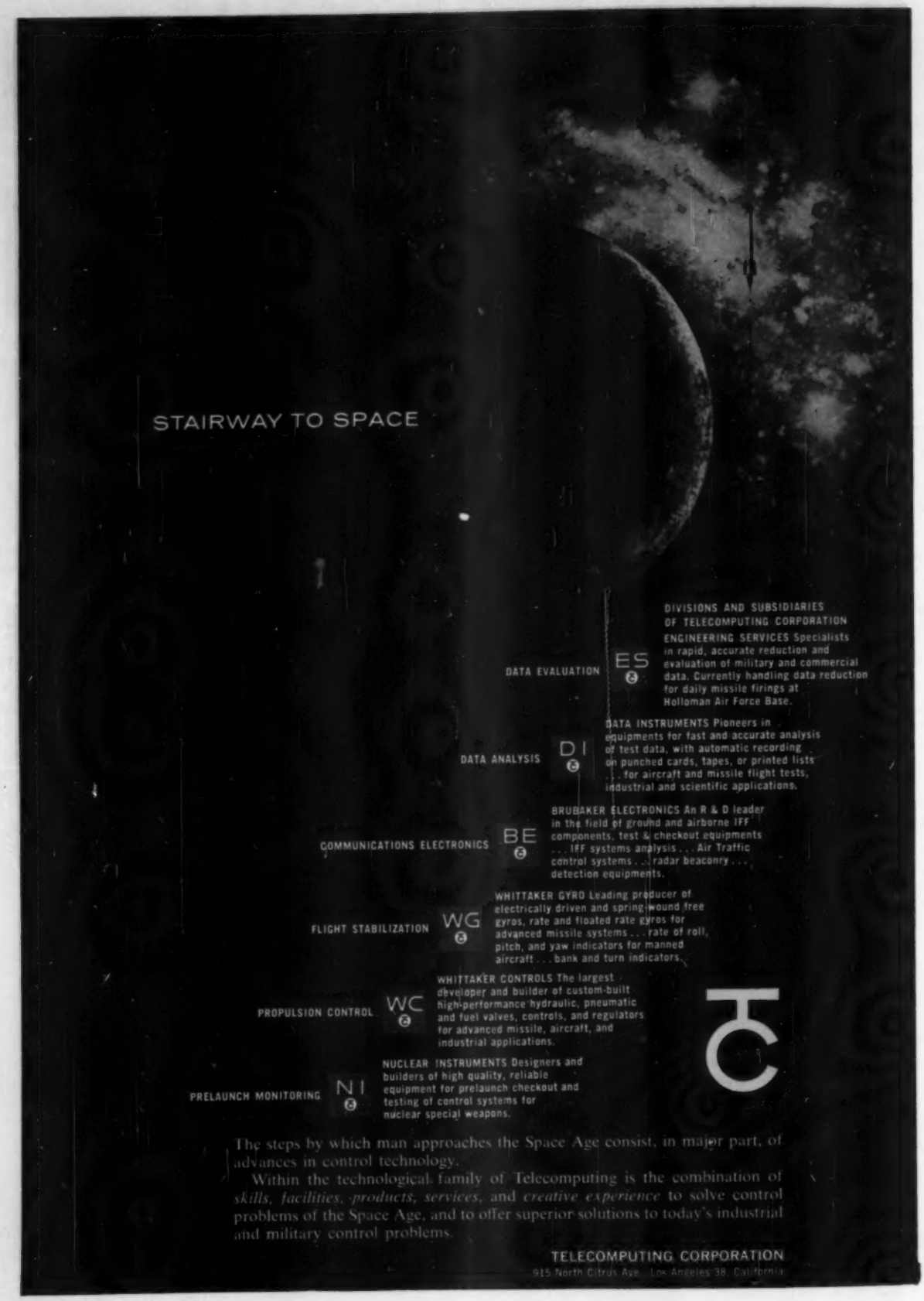
Pressurized to hold its shape, a 60-ft. tank for USAF Atlas intercontinental ballistic missile (above) moves to the final assembly area at Convair-Astronautics Division of General Dynamics' Atlas manufacturing plant. Tanks on floor still have support rings. Stainless steel sheets form tank sections (below).



Sheet of thin, but rugged, stainless steel is unrolled (left) for fabrication into a section of the Atlas ICBM tank. On final assembly line, the tank is mated to propulsion section and other systems—control, guidance, etc.—are added. At right, temporary supporting rings hold the steel in circular form.



Automatic welding machine butt-welds the ends of the steel strip, which is stretched on a circular form. Weld will be reinforced with a narrow underlay strip of stainless steel. Completed tank is 10 ft. in diameter; there is no internal bracing.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Micromodules Resist Heat and Radiation

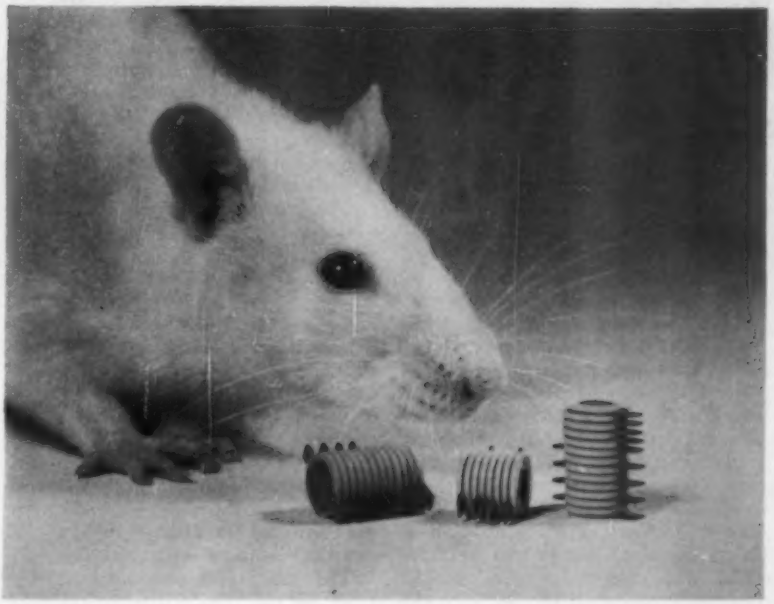
By James A. Fusca

Philadelphia—Ceramic components that can be stacked in micromodules and that operate in the temperature range between 500 and 600C are being readied for pilot production by the Receiving Tube Department of General Electric. Designated TIMM, for "thermionic integrated micromodules," the devices have the additional advantage of being highly resistant to the damaging effects of nuclear radiation.

This approach to making avionic equipment both smaller and more compact appears to have a unique advantage in that the operational efficiency and over-all reliability of performance can both improve as the size of the components is reduced and as the component density is increased.

General Electric's approach to microminiaturization is similar in many respects to other micromodule concepts presently under study. It provides for extremely high component densities with standardized component packaging.

The chief differences are that very small, heaterless tubes are used in place of semiconductors, and that auxiliary cooling is eliminated.



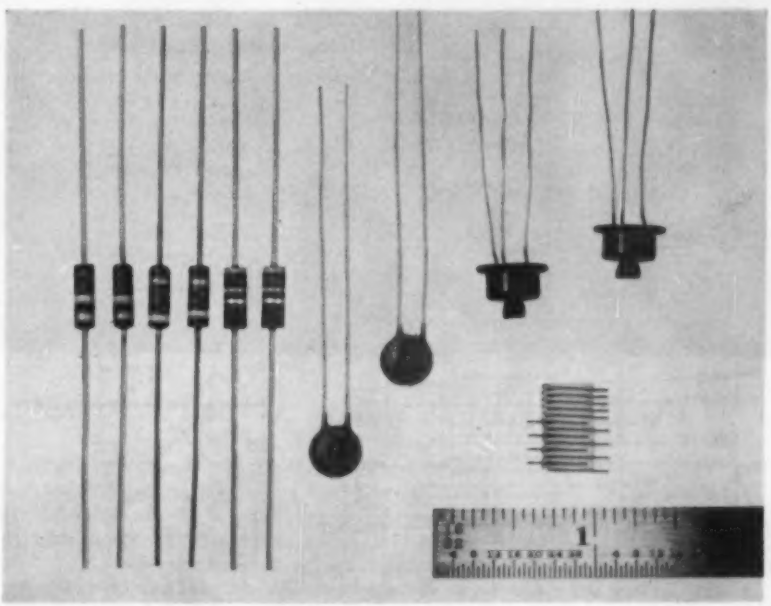
CERAMIC micromodules designed by General Electric tube engineers comprise complete electronic circuits, including vacuum tubes and associated resistors and capacitors. Designated TIMM, for thermionic integrated micromodules, the combination devices generate their own high operating temperature, in the range of 500 to 600C, and require only 0.75 w. to operate. (White mouse indicates comparative size.)

Extended Life

The heat losses generated within the equipment serve a useful purpose in that they increase the over-all efficiency of operation and contribute to the extended life and reliability of the equipment.

The company first announced its progress in a program for development of components to operate above 500C in September, 1956 (AW Sept. 10, 1956, p. 112). Basic studies and development of the TIMM concept have been conducted at the General Electric Research Laboratory and the company's General Engineering Laboratory. Present status of the program was described by General Electric engineers J. E. Beggs, Walter Grattidge and P. S. Molenda here before the Electronic Components Conference.

The program began with work to improve the environment in which an oxide cathode operates. The titanium-ceramic tubes that resulted were observed to have new and interesting characteristics, the most surprising of which was operation in the temperature range between 400 and 600C. From this came the idea of obtaining this performance by providing a high



TIMM micromodule at lower right comprises the equivalent of the conventional semiconductors, capacitors, and resistors shown. TIMM components developed to date include diodes, triodes, resistors, and capacitors that can be assembled in stacks measuring about 0.33 in. in diameter as long as the complexity of the circuit makes it necessary.

temperature environment even where one did not normally exist.

One method involves placing the titanium-ceramic tubes, together with other electronic components capable of operation at temperatures to 600C, in an insulated case containing a thermostatically controlled source of heat. The heat generated as the result of electrical losses in the tubes and components contributes to the internal heating of the case.

Component Density

If the component density is made sufficiently high, once the case is preheated, the electrical losses can provide essentially all the heat required to maintain the high temperature environment. In this manner, the reliable features of high temperature electron tube performance can be obtained with total power efficiencies approaching those realized with transistor circuits.

The high-temperature titanium-ceramic tubes which General Electric has developed require no filament or filament supply because, in the temperature range of 500 to 700C, there is sufficient cathode emission without filament heating. For example, in a tube designed to supply two milliamperes of plate current, the total available saturated emission from the cathode should be about 10 milliamperes. Operated at a temperature of 500C, one square centimeter of cathode area will supply 10 ma., or at 580C a cathode area of only 0.2 sq. cm. of cathode area will provide 10 ma.

Two types of tubes have been developed to date. One is a diode that consists of only three main parts: a titanium anode, an oxide-coated cathode, and a ceramic insulator. An experimental triode uses an additional insulator and a grid made up of a piece of perforated titanium supported by a titanium ring. The parts are stacked, exhausted and sealed in vacuum at a temperature of about 1,000C.

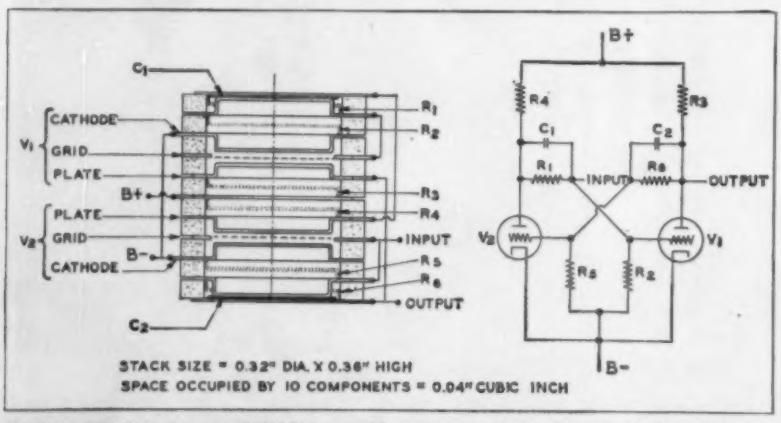
With the experimental triode being operated at extremely high temperatures, it might be expected that the grid would emit electrons as it accumulated barium oxide evaporated off the cathode. The grid is constructed of titanium, however, which absorbs oxygen and leaves only a partial layer of barium on the grid surface. As a result, the ratio of grid to cathode emission is only about 1,000,000 to 1. This small grid emission produces a positive contact potential between plate and cathode which results in a "built-in" grid bias of about two volts. By taking advantage of this characteristic, General Electric is developing a tube which requires no external grid bias, yet has no appreciable grid current until the grid signal exceeds two volts.

Heaterless titanium-ceramic diodes and triodes have been operated on life tests at various temperatures between 350 and 600C. The characteristics, engineers say, remained markedly uniform in all respects. Total emission, plate current, built-in bias, transconductance and the plate resistance were not observed to change over several thousand hours of operation.

The tubes also performed satisfactorily in electronic circuits that were exposed for 1,000 hr. to high levels of nuclear radiation. These exposures included flux densities of 9 x 10^{11} slow neutrons and fast neutrons per square centimeter per second, and 4.5 x 10^{11} gamma photons per square centimeter per second.

Microminiature Resistors

The high temperature resistors developed as part of the over-all program are made with some of the same titanium and ceramic parts that are used for the tubes, and are evacuated and sealed in the same manner. The re-



CROSS-SECTION of a typical TIMM assembly is shown at left with its equivalent schematic diagram at right. Significant fact that can be seen in the cross-section is that various TIMM circuit components can be combined in assembly to save additional space and weight.

VOUGHT DESIGNS QUARTERS FOR SPACE EXPLORERS

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In spacecraft, these factors are even more important. They affect the design of the entire vehicle. They bring into focus the tremendously hostile environment of space, and a completely new regime of aeromedical problems.

In preparation, Chance Vought has marshalled space age research and design aids. A "hot-shot" wind tunnel for example – capable of duplicating terrific re-entry heats; and high-speed computers to calculate trajectories and orbits for solar system flight.

Vought is a member of the Boeing Airplane Company team in the Air Force competition to produce the highly advanced *Dyna-Soar* boost-glide vehicle.

At the same time, additional intensive company research programs are underway for putting man into space.

Astronautics is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high performance aircraft, electronics, advanced weapons, anti-submarine warfare, range systems management, commercial process control systems.

CHANCE VOUGHT
DALLAS, TEXAS

NEW THEATER OF AIR FORCE ACHIEVEMENT

The first astronauts have been chosen by the National Aeronautics and Space Administration, and Air Force pilots are among them. These men will blaze a trail into space. The first step will be soon – a boost into orbit, a capsule parachute journey back to earth. Next will come very high flights with controlled, glider-like landings. Then, one day, astronauts will pilot space cruisers throughout our solar system. Air Force, Navy and Marine pilots are taking the first step toward use of space in the NASA program, bringing the military pilot a giant stride forward in the evolution to spaceman.

ASW G

CHANCE VOUGHT
DALLAS, TEXAS

NEW in looks, new in efficiency, and forerunner of a great new line of MB vibration exciters... that's the new Model C125.

Once again leading the way, MB has achieved a radical step-up in magnetic circuit efficiency. This new shaker, barely larger than its predecessor, develops 10,000 pounds force output... a 43% gain! Conversely, it calls for less amplifier power than any other electrodynamic shaker of comparable force.

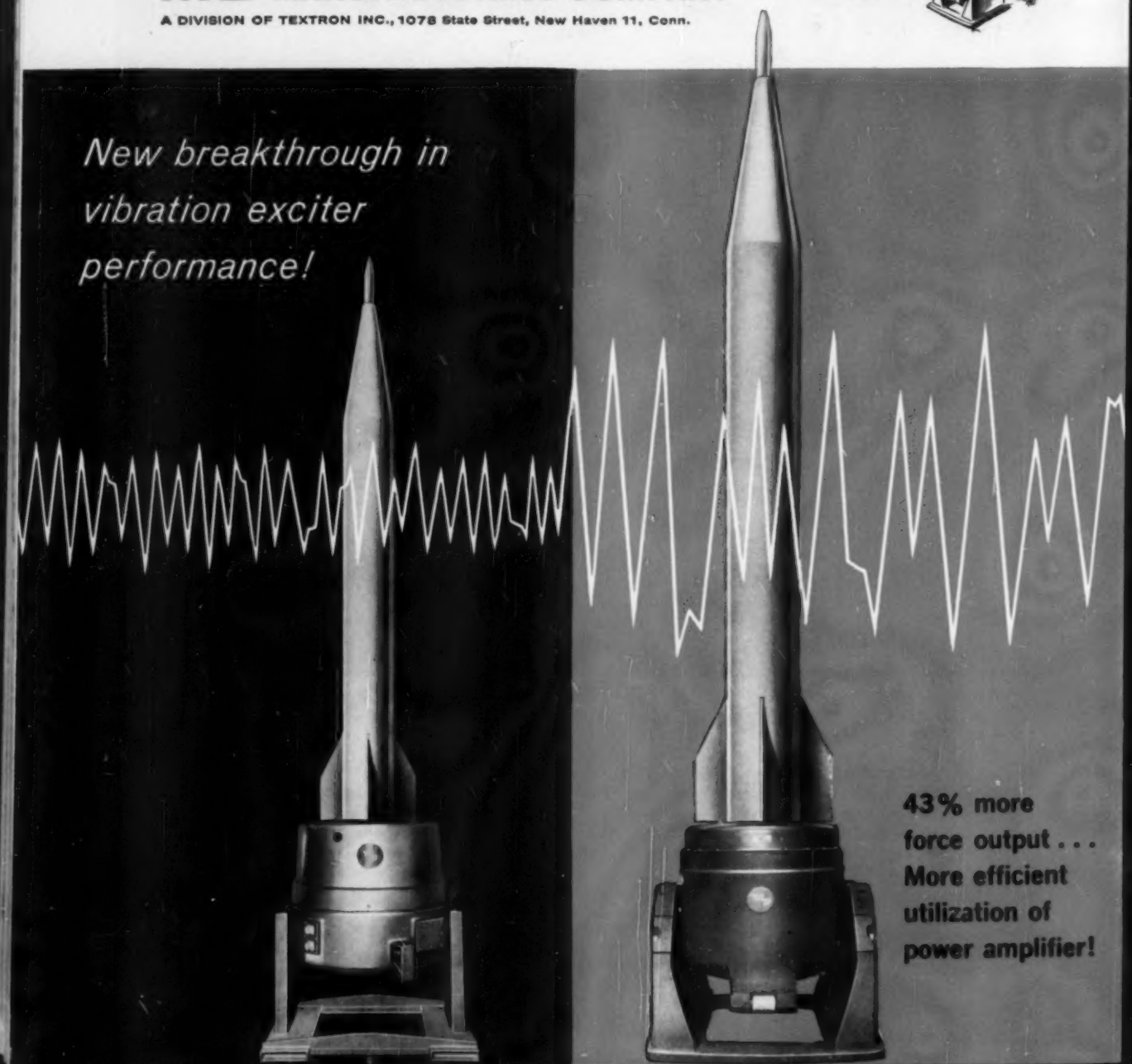
Leading companies in missiles, aircraft and electronics look first to MB for progress in complete vibration test systems. It has been that way for almost 15 years. Our "encyclopedia" of vibration experience is yours to draw on... as is the largest, national, field service staff of specialists. Send for full data.

Pioneer and leader in the field of vibration

MB MANUFACTURING COMPANY

A DIVISION OF TEXTRON INC., 1078 State Street, New Haven 11, Conn.

New breakthrough in vibration exciter performance!



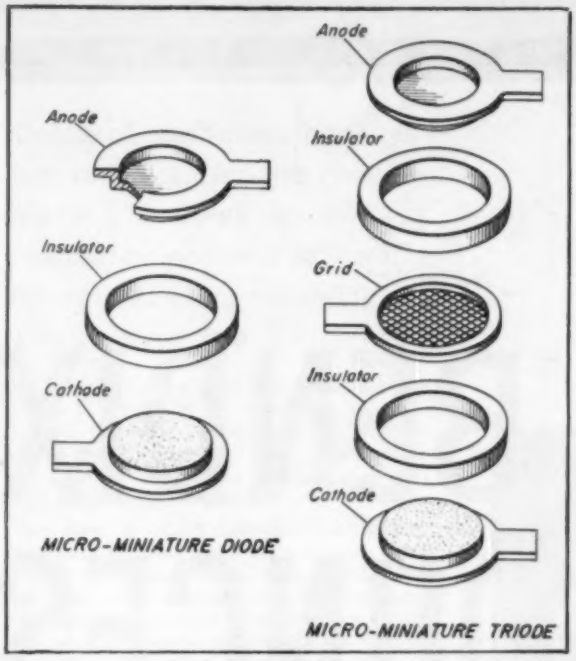
43% more force output... More efficient utilization of power amplifier!

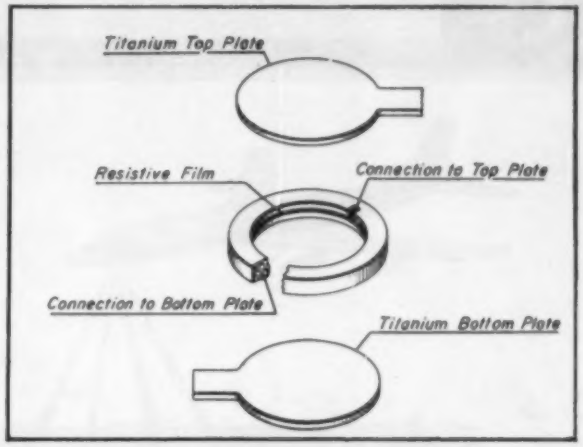
sistive film is placed on the inside surface of the ceramic insulator, and can be deposited in a way that allows the electrical connections to the terminals to be made at diametrically opposite points of the band. Resistors of this type have been made with resistance values as low as one ohm and as high as one-half megohm.

Microminiature capacitors have been made using the same titanium and ceramic parts for the vacum enclosure as the tubes and resistors. Synthetic mica sheets capable of withstanding the 1,000C exhaust and sealing procedure are used for the dielectric material. A capacitance of approximately 20 micromicrofarads is obtained by using a single piece of mica between the end plates. No changes in the characteristics have been observed for capacitors operated for several hundred hours at 580C.

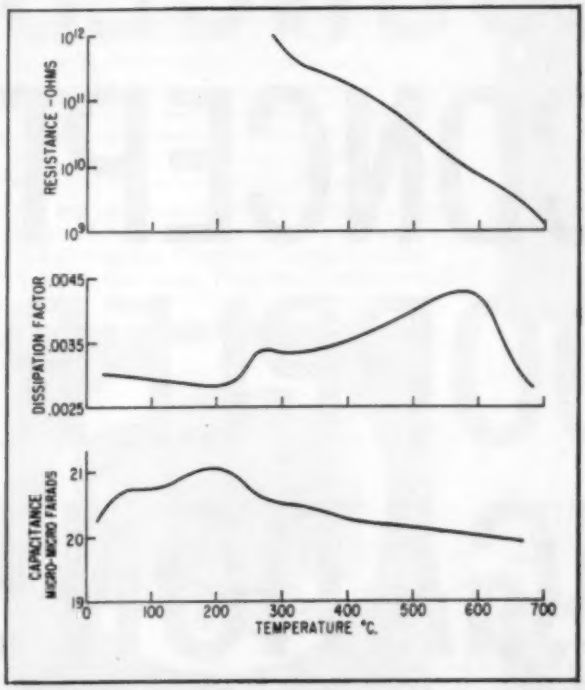
General Electric believes that a complete line of microminiature components can be developed for coordinated use with the present devices. Development models of various other high temperature components such as inductors and transformers have been tested at temperatures up to 500C and show promise of being stable and reliable, the company says.

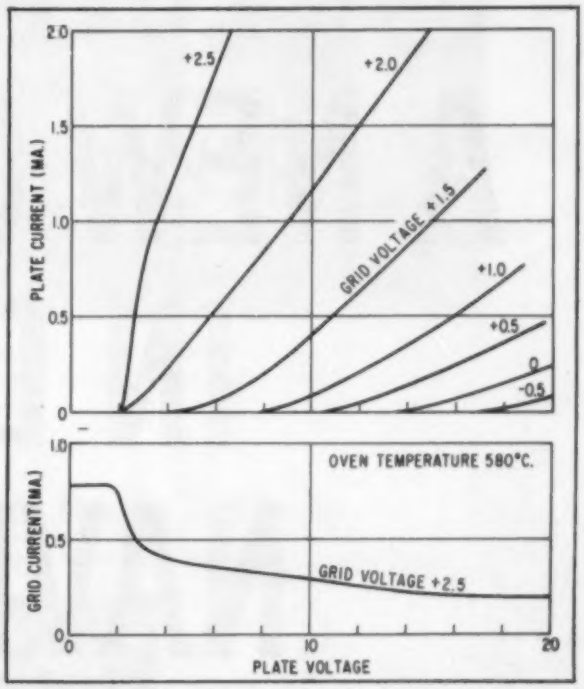
The microminiature tubes, resistors,





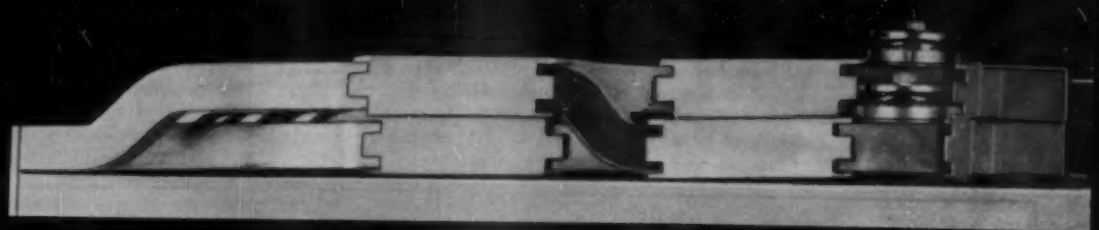
CONSTRUCTION of TIMM diodes and triodes is shown at left. The same end plates and insulators used in the diode are combined with an additional insulator and grid section to make up the triode. Construction of a TIMM resistor is shown above. The titanium end plates are the same as are used for the diodes and triodes. The insulator has a resistive film deposited around its inner surface that makes contact with the upper and lower plates at diametrically opposite points.



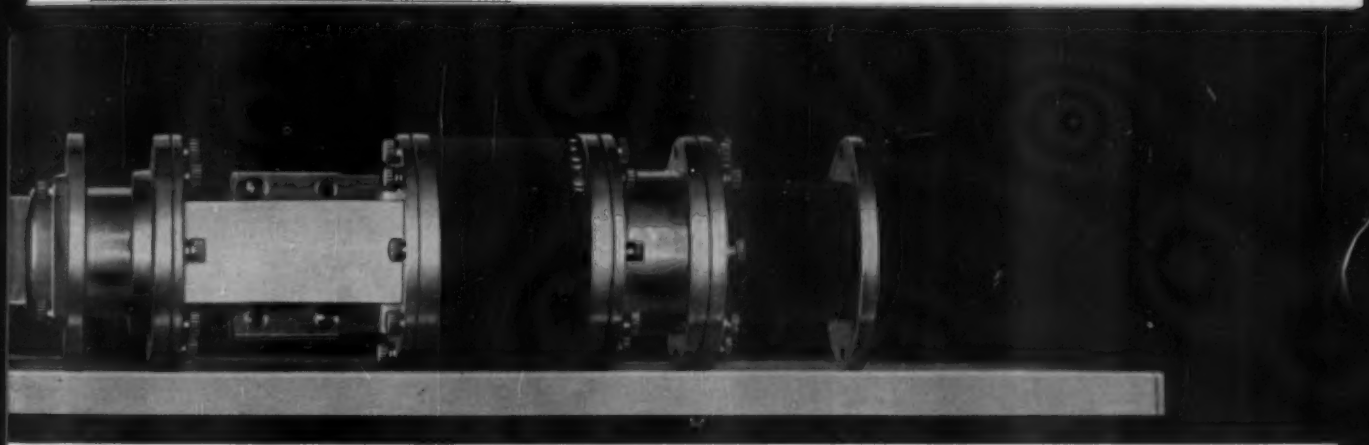


ELECTRICAL characteristics of a TIMM capacitor are shown at left, the electrical characteristics of a TIMM triode at right.

EXCLUSIVE . . . **Low-profile 4-beam planar array** easily installed in piston-engine aircraft as well as in jets and turbo-props. Only a single antenna required for dual systems. (½ ACTUAL SIZE)



BENDIX ANNOUNCES A NEW CONCEPT IN DOPPLER NAVIGATION!



Compact, self-contained system meets all jet-age requirements... features versatility of installation and ease of maintenance plus extra reliability... available for late '59 delivery

In announcing its new and revolutionary DRA-12 Doppler Navigation System, Bendix offers the *most practical* way to utilize the advantages of the Doppler radar principle in navigating today's high-performance commercial airliners.

The new Bendix* Doppler Navigation System combines compactness and light weight with greater performance reliability and easier installation and maintenance. One of the System's chief features is its exclusive low-profile antenna. This rigidly-fixed, four-beam planar array is *only 3½" thick*, will fit into existing accesses on many jets and turbo-props, and is ideal for retro-fitting in piston engine aircraft.

Only the Bendix system provides an extra beam—without sacrificing power—to double-check ground speed and drift angle readings. Ramp test unit and special shop test equipment will be part of the Bendix "package."

Get full performance details of the Bendix DRA-12 System and its companion CPA-24A Navigation Computer System from our Aviation Electronic Products Department.

*REG. U.S. PAT. OFF.

Indication of ground speed from 100 to 999 knots and of drift angle is instant and continuous.

Transistorized ⅜-ATR Transmitter/Receiver and ½-ATR Tracker Unit offer maximum performance and reliability in lighter, more compact packages.

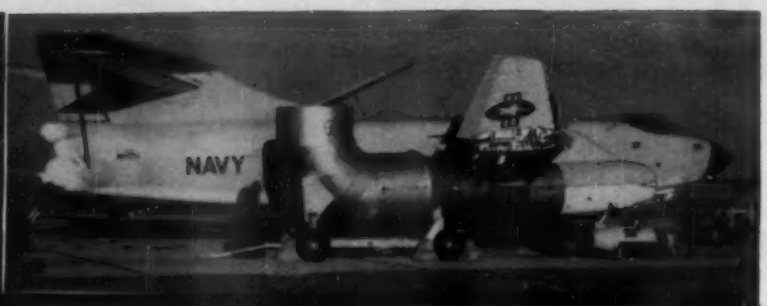
Bendix Radio Division

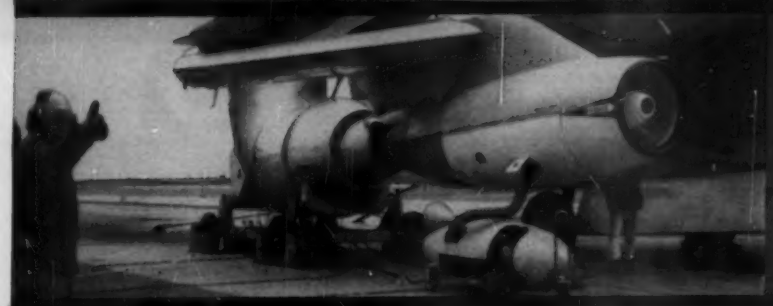
BALTIMORE 4, MARYLAND

Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

Bendix
AVIATION CORPORATION

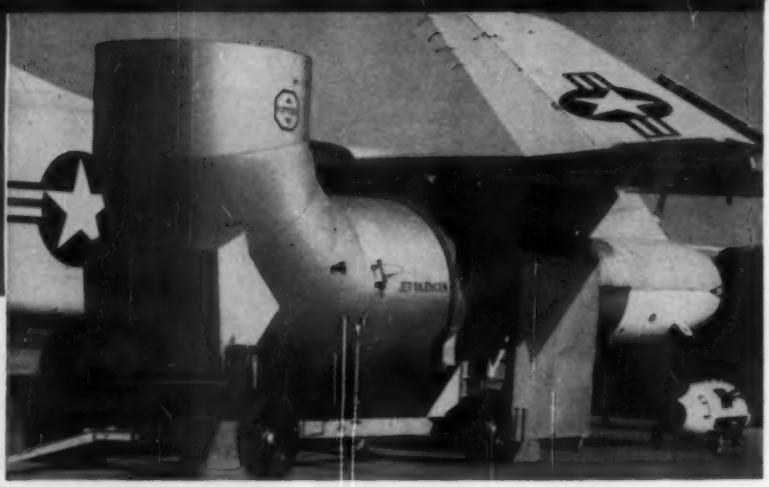
Roll up the Silencer—





Run up the Jet—

Knock down the Decibels!



For moderate, economical silencing of jet-powered commercial and military aircraft . . .

NEW KOPPERS PORTABLE RUN-UP SILENCER TAKES THE PUNCH OUT OF JET NOISE

Now, airports, air bases and manufacturers of jet engines or airframes can run up jet engines without complaint or creating physical hazards. The Koppers Portable Run-Up Silencer reduces noise by 25 to 30 decibels—lessens the risk of hearing damage to operating personnel, improves community relations and reduces speech interference.

The new portable silencer inhibits the generation of jet engine noise, rather than suppressing it after the noise has reached full intensity. The unit is light in weight and completely portable—no direct attachment to the aircraft or engine is necessary. Look to Koppers with its longest experience in the industry to solve your aviation noise control problems.

Write for Koppers new sound control brochure today. KOPPERS COMPANY, INC., Sound Control Department, 3503 Scott Street, Baltimore 3, Maryland.

Official United States Navy Photographs

KOPPERS

SOUND CONTROL

Engineered Products Sold with *Service*

Panel Selects, Composes Routine Messages

Traffic controller's routine communications with aircraft, using Automatic Ground-Air Communications System (AGACS) being developed by Radio Corporation of America, will be displayed on a panel similar to the one shown on this mockup. Data Entry Handset, being operated above, will be used to select and compose routine messages. First experimental AGACS is slated for delivery to Federal Aviation Agency this summer for evaluation.

and capacitors that have been developed can be stacked together to form operating circuits. Only a few external connections are required because many of the connections are inherent in the stack. Since the cathode derives its operating temperature from the environment in which the stack operates, no cathode heaters or connections to them are necessary.

Cathode bias resistors and capacitors are unnecessary because of the built-in bias feature of the triodes. The fact that the components are small, that they can be compactly arranged in the stacked circuits and interconnected with short jumpers, suggests that good high frequency performance should be possible.

Stacked Circuits

The small size of the stacked circuits permits a large number of such building blocks to be assembled in a small space. For example, two stacks performing the function of input "and" gates, two "logical" flip-flop stacks, and two dual unit "cathode follower" stacks altogether incorporate a total of 44 components. These are 10 diodes, 14 triodes, 14 resistors, and six capacitors. Placed end on end they can be fitted into a stack 0.32 in thick by 0.50 in. wide by 2.6 in. long. This is a circuit density of 250,000 components per cubic foot.

In describing the potential of the new components and the concept behind them, the General Electric engineers said that practical circuits can be constructed with the devices that have already been developed. These circuits are smaller, lighter, and generally require fewer components than their conventional encapsulated semiconductor counterparts.

With this approach, General Electric's tube engineers appear to be challenging the expanding role of semiconductors in many avionic areas. They say that circuits using the devices seem to offer fewer temperature problems, higher reliability, longer life, greater ruggedness, resistance to nuclear radiation, and higher operating speeds without sacrificing the power levels of their printed circuit or encapsulated predecessors.

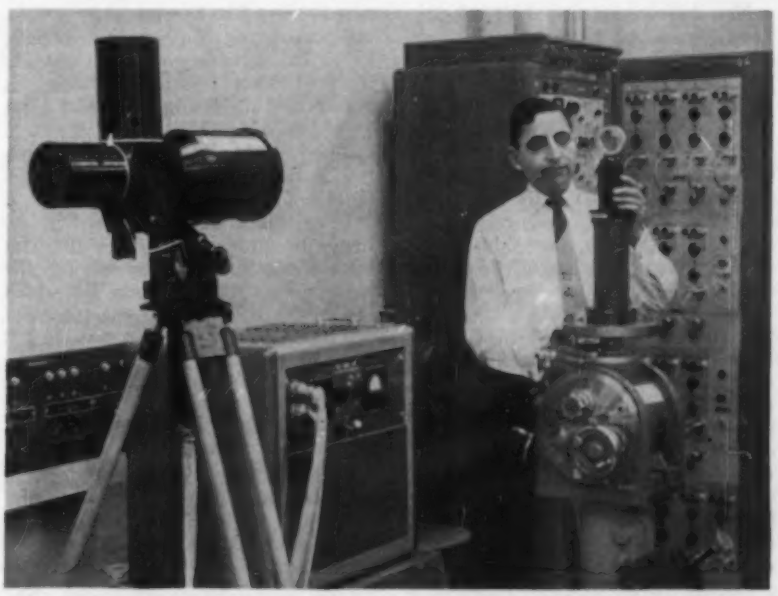
Alignment System Utilizes Infrared

Dallas—Chance Vought Aircraft has developed an infrared device called OPAL which offers a new technique for automatic optical alignment of inertial guidance systems and other azimuth reference devices.

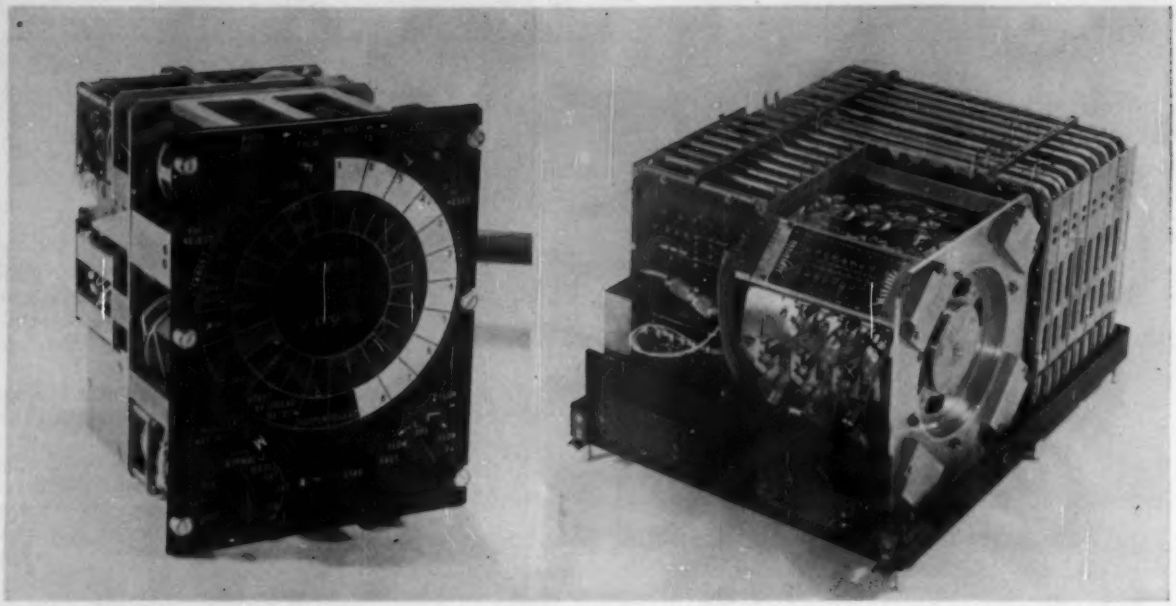
Optical Planform Alignment Linkage (OPAL) can improve accuracy of alignment of guidance systems by using a new principle involving infrared light beams and a highly sensitive detector, according to its inventor, Senior Scientist Grayson Cocharo. Accuracies as high as three seconds of arc can be obtained.

OPAL transmission source emits two beams—a non-polarized divergent conical "coarse" beam and a narrow, polarized, collimated "fine" beam. A photo-telescope responds to both, and signals derived from the "course" beam are used to servo-control the source in both azimuth and elevation to direct beams toward the detector.

Photo-telescope is aligned precisely parallel to the axis of the collimated beam by using signals from the "fine" beam. "Fine" beam contains optical parallelism information, and parallelism can be maintained over a large optical field allowing compensation for position displacements and angular rotations.



OPAL demonstration model is adjusted by its inventor, Grayson Cocharo. Components are: from left, infrared light source, electronics package and photo detector.



AN/ASN-24 airborne digital navigation computer, developed by Librascope, has cockpit console controller (left) and computer-memory unit (right). ASN-24 makes dead reckoning, inertial and celestial navigation computations. It weighs 32 lb. and occupies 0.55 cu. ft. Modified version of the all-transistorized computer may be used in the Air Force's WS-138A air-launched ballistic missile.

Computer Combines Navigation Duties

By Philip J. Klass

Washington—Flight evaluation of USAF's new AN/ASN-24, a miniaturized airborne digital computer which automatically provides the answers to almost any navigation question a pilot-navigator could ask, will begin soon at Wright Air Development Center in a Fairchild C-119 aircraft.

New fully transistorized digital computer, developed by Librascope, Inc., under WADC's Weapons Guidance Laboratory sponsorship, weighs only 32 lb., occupies just 0.55 cu. ft. and consumes only 100 watts of power.

The ASN-24 is designed to operate with inputs from several or all of the following: Tacan, Doppler radar, star tracker and inertial references. Working from such data, the ASN-24 provides pilot-navigator with the following:

- **Present position:** Latitude and longitude, with computational errors of no more than 0.07% of total distance traveled.
- **Destination:** Great circle course, bearing, and time to reach destination, or an alternate.
- **Deviation from flight plan:** Distance off desired ground track, time ahead or behind schedule, are some of the data that can be provided.
- **Moving target:** Bearing and range to a moving target, or to a future collision point with a moving target, can be computed and displayed.
- **True heading** and magnetic variation.
- **Wind direction** and velocity.

A second prototype model of the ASN-24 has been delivered to USAF's Tracals Project for evaluation. Unit has slightly different display and controls than first model that went to Weapons Guidance Laboratory.

Modified version of the ASN-24 is included in the inertial guidance system developed by Kearfott, a sister General Precision Equipment affiliate, which has been proposed by eight different bidders for USAF's new air launched ballistic missile, WS-138A (AW May 11, p. 34).

The ASN-24 also can be used to control a battery of mapping reconnaissance cameras, Librascope says.

Librascope's new computer is designed to automatically check itself for internal malfunction by periodically performing a test problem for which the answer is known. If the computer detects an internal malfunction, it will automatically switch to a standby device (if available) and/or alert the pilot-navigator.

The computer also is designed to perform credibility checks on input data. If signals from Doppler radar, Tacan receiver, inertial or celestial system are significantly different from the previous signal value, the computer rejects such data. When no external radio signals or star sights are usable, AN/ASN-24 functions as a dead-reckoning computer from airspeed or Doppler radar signal and heading information.

The magnetic drum, which serves as computer memory, is used to store such data as magnetic variation as a function of heading, declination and sidereal hour angles of up to 57 stars which may be used by a star tracker and Coriolis correction as a function of airplane ground speed and lattitude.

The pilot-navigator manually sets in such information as latitude and longitude of takeoff point, destination and three alternates and locations of three Tacan ground stations. During flight, the pilot can select new destinations, alternates or Tacan stations, if desired, using cockpit controller. At any time, the pilot can set in coordinates of a moving target, obtained from ground intercept radars, and computer will calculate a pursuit or collision course for interception.

The AN/ASN-24 is a general purpose, two-address, serial, binary data, general purpose computer. The storage drum, which rotates at 6,000 rpm. has a storage capacity of 2,048 words, each 25-bits in length. Analog-to-digital conversion of incoming signals is performed within the computer itself.

Silicon transistors are used throughout, enabling the computer to operate over a temperature range of −55C to 100C, and at altitudes up to 70,000 ft. Computer accuracy is unaffected by power supply voltage variations of 20% of electrical noise level in supply source, according to Librascope.

FILTER CENTER

▶ **More funds for molectronics**—Air Research & Development Command hopes to obtain $2-4 million in Fiscal 1960 funds with which to sponsor developments in molecular electronics. ARDC official says that a number of companies have come in to seek sponsorship of small-scale molectronic programs being carried on with company funds, following AVIATION WEEK's report on ARDC's new $2 million molectronic contract award to Westinghouse Electric (AW April 27, p. 54). List of companies includes: American Bosch Arma, Boeing, General Electric, Hughes Aircraft, International Business Machines, Radio Corporation of America, Shockley Laboratories, Sylvania, Sperry Gyroscope and Texas Instruments. Current industry interest is indicated by fact that Institute of Radio Engineers has been asked to form a Professional Group on Molecular Electronics.

▶ **Avionics Short Courses**—Summer short courses of particular interest and importance to avionics engineers include the following:

• **Infrared:** Theory and Applications of Infrared Radiation and Detection, July 20-31, University of California, Los Angeles, sponsored by Infrared Information Symposia (IRIS). Enrollment fee is $150. For information, write Dept. K, University Extension, University of California, Los Angeles 24, Calif.

• **Communications:** Reliable Long Range Radio Communication, Aug. 17-18, Massachusetts Institute of Technology. Tuition is $275. Application forms are available from Directors of the Summer Session, M. I. T., Cambridge, Mass.

▶ **Signed on Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Federal Electric Corp.**, Paramus, N. J., $1.5 million contract from Navy for operation of range instrumentation at Pacific Missile Range, Pt. Mugu, Calif. Rheem Manufacturing Co. and Marquardt Aircraft are subcontractors to Federal.

• **Collins Radio** reports order for more than $4 million from Aerolineas Argentinas for HF and VHF communications and navigation equipment for use on airline's de Havilland Comet 4s.

• **Robertshaw-Fulton Controls Co.**, Aeronautical and Instrument Division, Anaheim, Calif., $1.4 million contract from Convair for component of F-106 stability augmentation system, used when airplane is under control of Hughes fire control system.

Only CHERRY Gives You HIGH CLINCH RIVETS*

A Complete Line For The Aircraft Industry

the Cherry "600" Rivet—in A-286 Stainless Steel
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Industry-proven Cherry High Clinch Rivets offer advantages superior to any other blind rivets: (1) Superior Clamp-up, (2) Complete Hole Fill, (3) Positive Inspection, (4) Uniform High Pin Retention, (5) Wide Grip Range.

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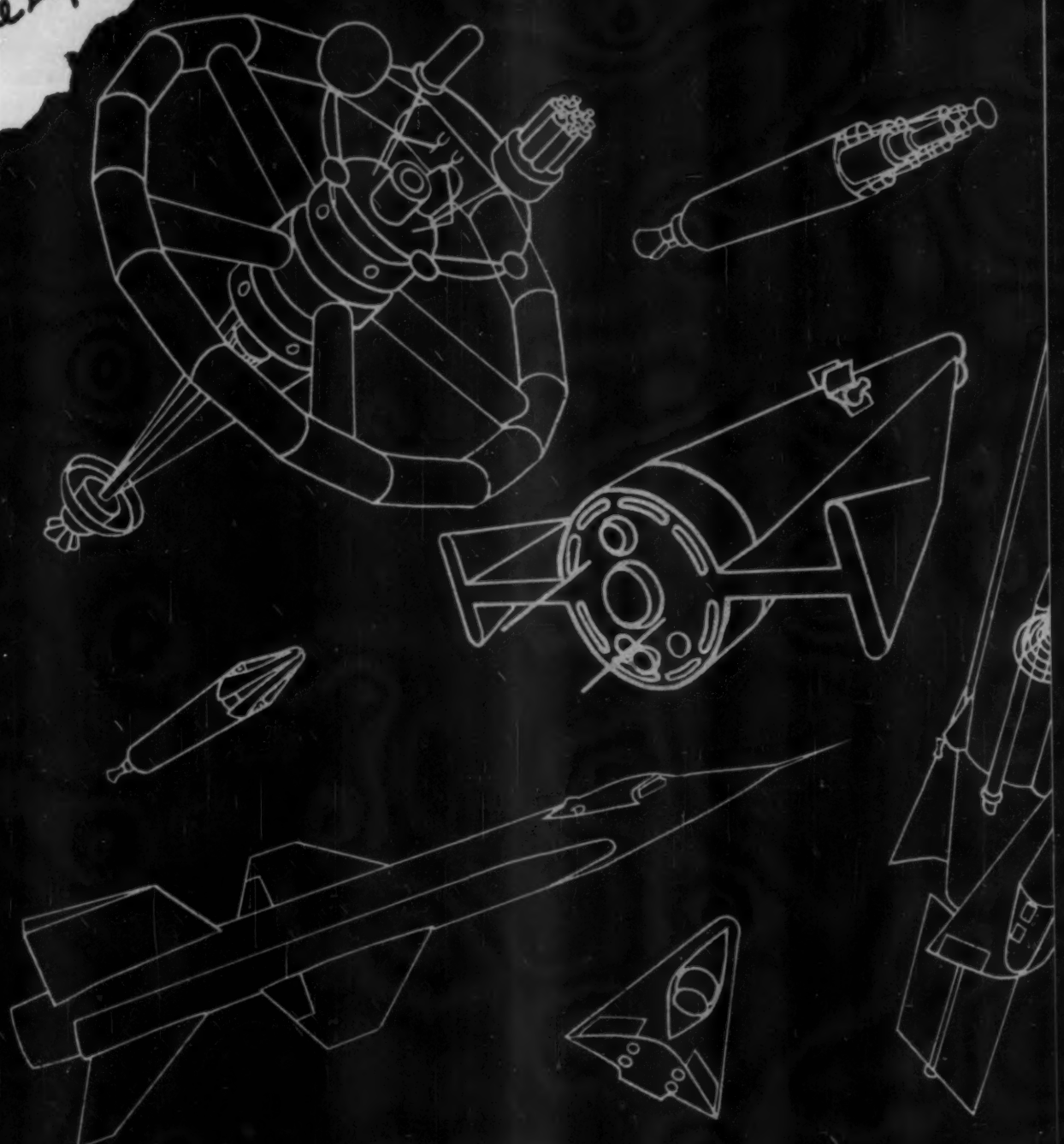

in space...
space exploration"

AVIATION WEEK's 1959 R&D issue will be titled, "The Next Decade In Space —Blueprint for U. S. Space Exploration." This special report, the first of its kind to be presented, will plot the nation's space exploration for the next 10 years. This special editorial presentation will be featured in an illustrated section published in insert form to meet the requirements of scientific, military and industry planners.

AVIATION WEEK Including Space Technology has pioneered in this kind of technological reporting and has established world wide recognition in covering the advanced areas of aeronautical and space development.

This year, the special report will appear as part of the June 22nd issue and will include:

1. Current and projected financing of special research, development and operational programs.
2. Technical details of the vehicles with which they will be carried out.
3. The scientific goal at which these programs are aimed.
4. The administrative and contracting methods for executing them.
5. The progress of the U. S. space effort up to the date of publication.

We urge you to take advantage of this significant opportunity by advertising to AVIATION WEEK's audience of 73,750 engineering-management men in this vital and timely issue.

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Johns-Manville announces new **MIN-KLAD** Insulation!

This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

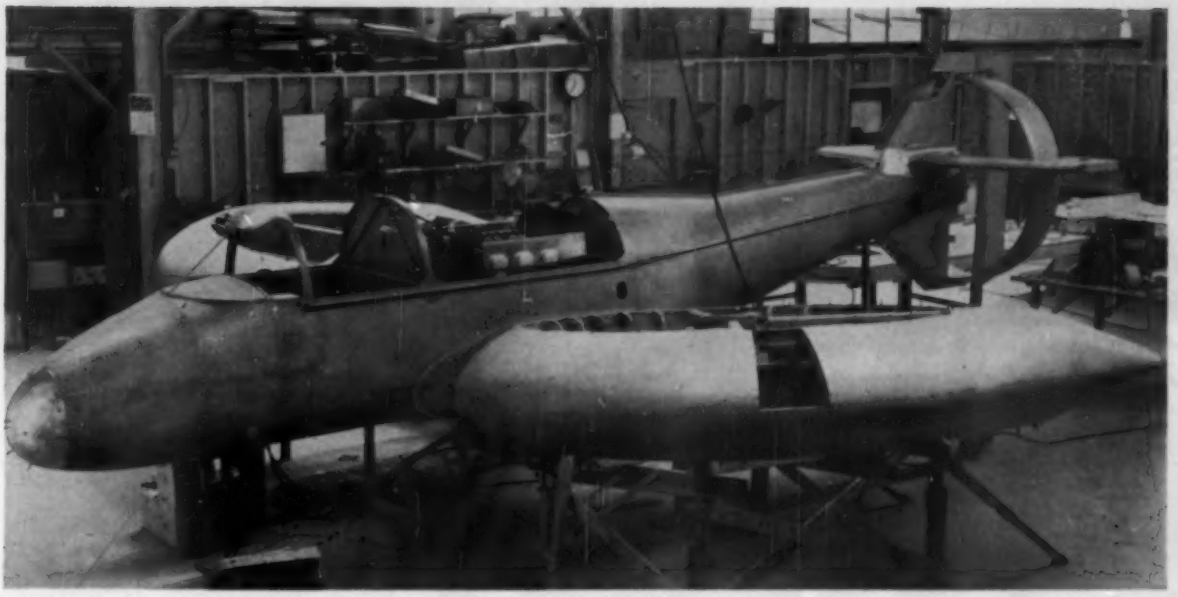
It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS



VANGUARD 2C, approximately 90% complete, will have retractable lids fitted to upper portion of wings covering ducts.

Fan-Wing Vanguard 2C Nears Completion

By Erwin J. Bulban

Paoli, Pa.—First full-scale fan-wing configuration vertical takeoff aircraft is nearing completion near here under the direction of two former Piasecki engineers who are scheduling the start of a tunnel test program at National Aeronautics and Space Administration's Ames Laboratory in July and flight tests in August or September. Both military and business aircraft versions of the new VTOL are contemplated by the designers.

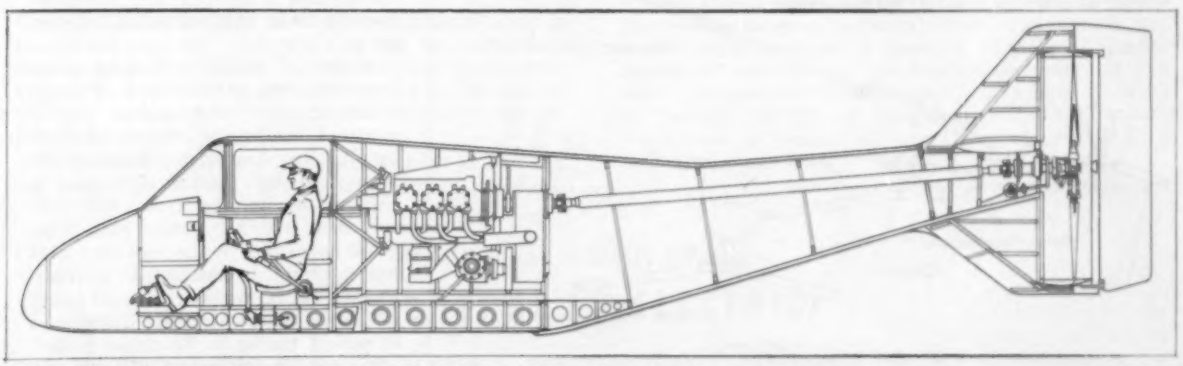
Vanguard Air & Marine Corp.'s Model 2C VTOL is expected to fill an important niche in a current intensive program of vertical takeoff aircraft development under way in this country—that of the ducted wing configuration.

The Model 2C project thus far has been entirely privately financed, but recommendations for a full-scale wind tunnel test program have been made by USAF's Wright Air Development Center to Air Research & Development Command. Ames Laboratory, which has been doing some model research on a fan-wing configuration, is interested in collecting full-scale data, Vanguard President Edward G. Vanderlip and codesigner John J. Schneider told AVIATION WEEK.

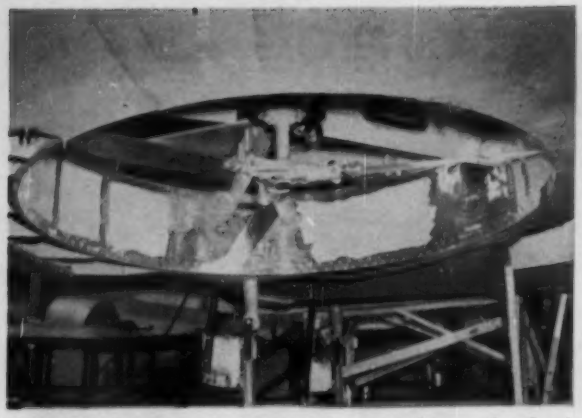
Vanguard has put considerable effort in design refinement of the airframe of its first aircraft to provide a vehicle suitable as a testbed and also for practical evaluation of the military mission capability and also as a demonstrator which would not require too much imagination in visualizing the configuration as a civilian executive transport.

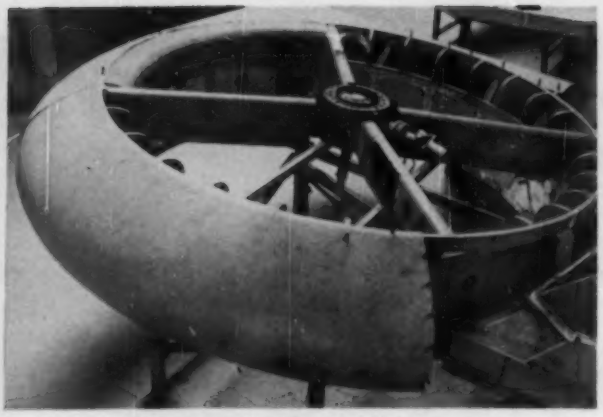
Vanderlip feels that Vanguard's resources are currently too limited to provide a large-scale production capability, particularly for the executive version. He also feels that the company would have to merge with an established manufacturer to provide necessary production and distribution facilities. Some 20 persons now are working on the Model 2C in a 6,000-sq.-ft. leased area.

Vanguard studies indicate that a four-place version of the Model 2C, powered by the new 520-hp. Lycoming ISO720 engine, providing a cruise speed of 200 mph. and 550-mi. range, could sell for under $40,000 at a production rate of 1,000 units a year. Vanguard Model 8

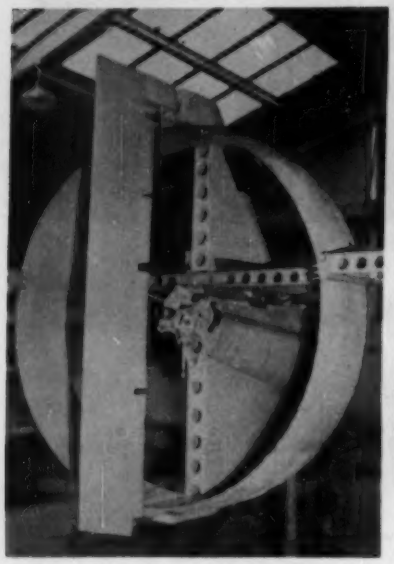


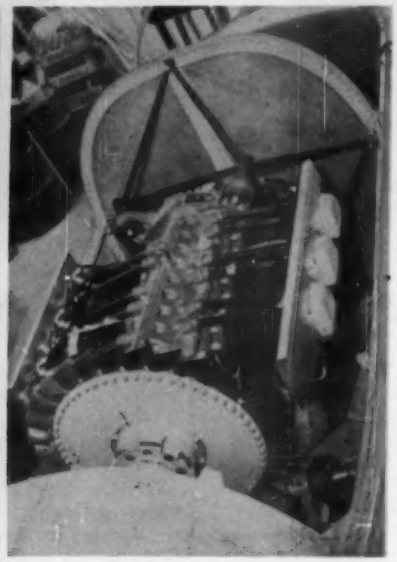
FUSELAGE-BURIED ENGINE transmits power to ducted pusher propeller via shaft approximately 10 ft. long.



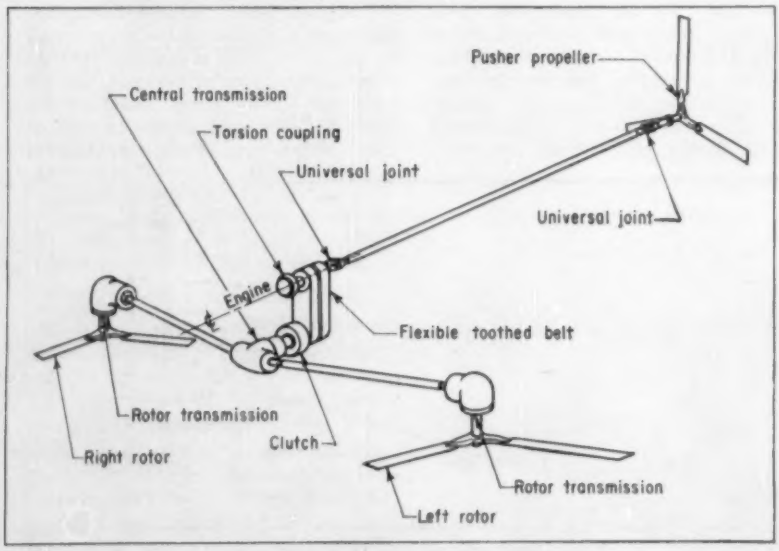


THREE-BLADE wing rotor is mounted temporarily in underside of wing duct (left). Four streamlined stators (right) carry rotors.





DUCT for tail-mounted propeller is five-foot diameter, is expected to improve propeller efficiency some 10%. Engine (right) has 25-in. cooling fan attached. Transmission system (below) and rotor-propellers are former Jacobs convertiplane components.



would have a top speed of approximately 260 mph.

Another Vanguard fan-wing concept, Model 7, would be a battlefield VTOL transport with a capacity of 32 troops or 8,000 lb. of cargo and a cruise speed of 288 mph., vertical climb rate of 300 fpm. and a range of 575 mi. It would have a mission hover capability of 10 min.

Powerplants would be two 5,500-eshp. Allison T61s.

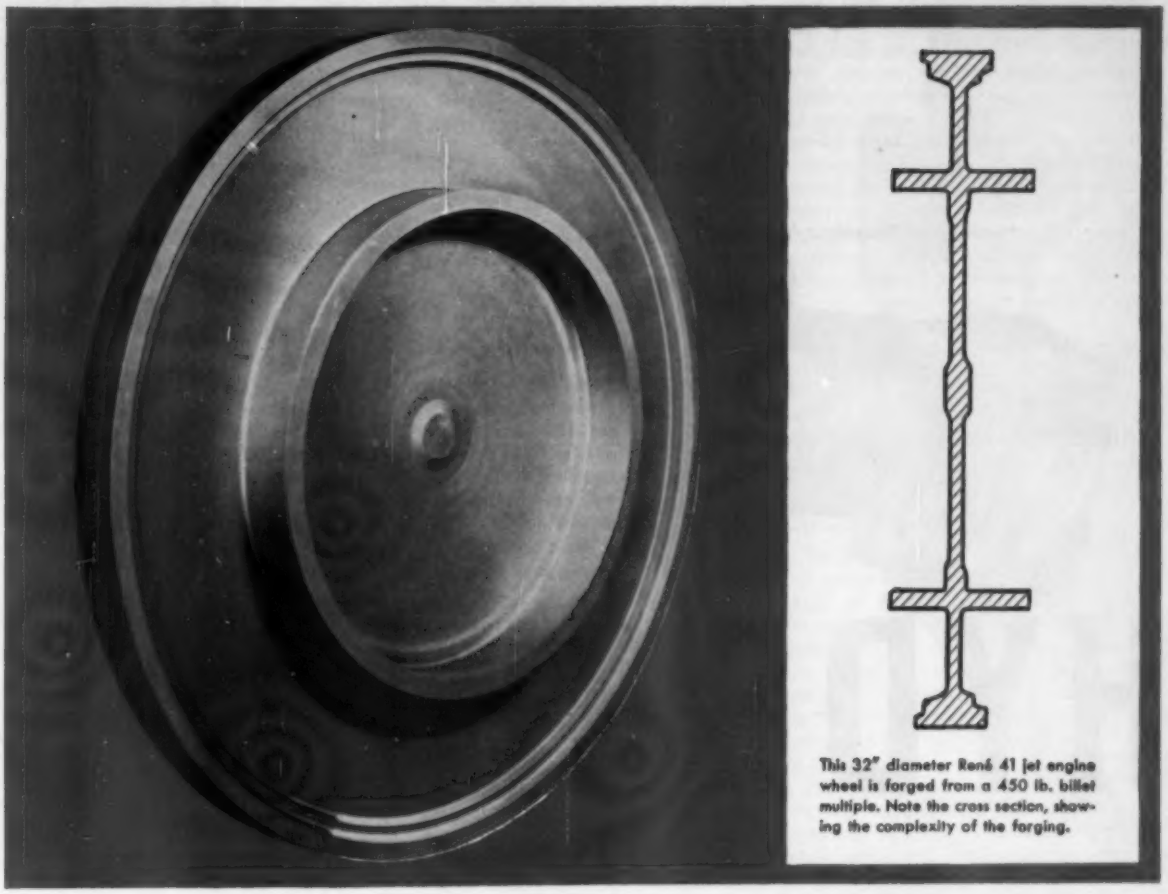
Powered by two Allison T56 engines, the Model 18 short haul transport would be capable of carrying 36-40 passengers at a cruise speed of about 275 mph. Gross weight would be approximately 30,000 lb. and useful load 9,880 lb.

Convertiplane Parts

A major factor in design and construction of Vanguard Model 2C was that the company utilized a dynamic system composed, for the most part, of components of the former Jacob's convertiplane project, including rotors, clutch, transmissions and shafting. The company procured all of these parts plus drawings, test data, patterns for making castings and dies for extruding blades, for a fraction of their estimated $1.5 million value. Much of the system had undergone some 150 hr. of testing on the original convertiplane project and Vanderlip and Schneider consider them well-proven for test purposes.

Model 2C basically is a two-place low-wing configuration with a single Lycoming O540-A1A piston engine mounted behind the cockpit, developing 265 hp. The engine normally delivers 250 hp.; increased output is obtained by running it at 2,800 rpm. and using 100/130 octane fuel. Vanguard hopes that by the time its tunnel test program is completed, a supercharger will be available to boost power to 380 hp. Current rating is sufficient to permit testing in the Ames tunnel, but the additional power will give the

Metallurgical Memo from General Electric



This 32" diameter René 41 jet engine wheel is forged from a 450 lb. billet multiple. Note the cross section, showing the complexity of the forging.

WORKABILITY: the plus ingredient in General Electric's René 41

Metallurgical Products Department reports on a versatile high-temperature alloy that can be *forged* into heavy, complex shapes, drawn into fine wire, rolled into bar and sheet

General Electric's René 41* high-temperature alloy is one of the strongest materials that can be successfully formed, forged, or welded. It retains high strength even at 1800°F., yet can be forged into heavy, complex shapes. *No alloy with comparable mechanical properties can approach the workability of René 41.*

For example, complex jet engine wheels 32" in diameter are being forged from 450 lb. multiples of René 41, vacuum-induction-melted by General Electric. These wheels, having a tensile strength of over 100,000 psi at 1650°F., must offer absolute dependability for pilot survival. René 41 is so ductile that it can also be drawn into wire as fine as .001".

René 41 was developed by General Electric to extend the working range of high-temperature components, and is now being produced in quantity to the rigid quality standards required for the aviation industry. If you would like more technical information on René 41, write for Bulletin VM-107. Or contact: *Metallurgical Products Department of General Electric Company, 11107 E. 8 Mile Blvd., Detroit 32, Michigan.*

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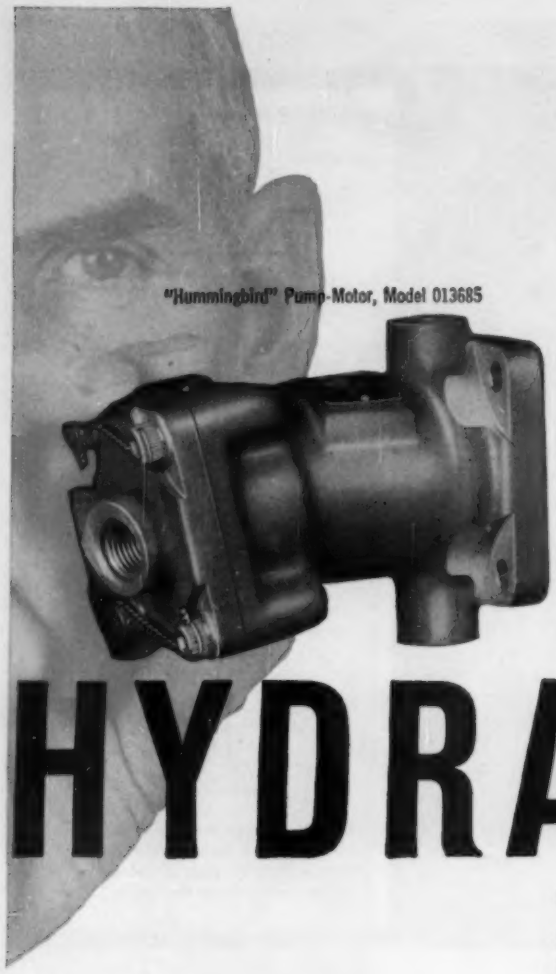

"Hummingbird" Pump-Motor, Model 013685

Creative engineering ...for the space age

Miniature Pump-Motor, a remarkable Pesco development in hydraulics, saves critical space and weight on jets and missiles. Piston-type hydraulic unit can be used as either pump or motor without modification for rotation in either direction. Model shown here delivers 2.5 gpm at 3000 psi, operates at 24,000 rpm from direct drive, weighs 2.1 lbs., handles fluids from —65° to 550° F. All-steel unit features spherical piston ring, all-metal O-rings, constant-velocity universal joint. Basic design can be varied to meet your specifications.

This is but one of many exciting Pesco developments in hydraulic pumps, motors, power packages, servo valves.

HYDRAULICS

The miniaturized pump-motor shown here demonstrates Pesco capabilities for engineering high-performance hydraulic components. These can be applied to your space age program wherever pressurized flow and precise control of fluids are vital.

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Pesco creative engineering is strongly supported by modern facilities, fully equipped for research, development, design, prototype production, qualification testing and quantity manufacture.

desired power margin the company feels is needed for free-flight trials.

The engine is insulated from the cockpit by a stainless steel firewall. There are removable panels atop the fuselage to provide access to the powerplant. Cooling for the submerged powerplant will be provided by a 25-in.-diameter fan attached to the starter ring.

Carburetor air is ducted from the fan through an air filter.

Engine power is transmitted through a torsional coupling to a pulley shaft and then aft to the tail propeller, using universal joints and shaft. Power is transmitted to the ducted rotors in the wings by toothed rubber belting to the central transmission shaft. The belt system will be utilized only on the prototype, Vanderlip explained. Lateral shafting from the central transmission connects to the rotor transmissions. A friction-type engaging clutch is installed between pulley sheaves and central transmission to permit disengagement of the wing fans during forward flight.

Bevel Gears

Only eight bevel gears are used in the entire system; all are identical 1:1 ratio straight-tooth Maag-type—three gears are in the central transmission and two each in the wing-fan transmissions. Gears are designed for a minimum of 2,000 hr. life; bearings are designed for 1,000-hr. minimum life and since the drive and rotor systems are used only for a few minutes during each flight, Vanguard expects a minimum of service problems with this configuration.

Three-blade wing rotors are fabricated from 24ST aluminum alloy extrusions and are mounted on flapping hinges and pitch bearings. Blades have 26-deg. twist to improve lift distribution at tips. There are no drag hinges. Pitch bearing housing consists of a pitch bearing assembly in which a pitch shaft rotates. Inside the assembly, a stack of tension-torsion straps are pinned to the pitch shaft on its outboard end and the flapping pin to the inboard end.

Pitch changes are provided by the low torsional stiffness of the straps. Outboard end of the pitch shaft is formed into a fork to which the blade attaches. Droop and flapping stops are fitted to inboard lug ends of the pitch housing. Collective pitch controls consist of a swashplate and linkages. Total weight of the aircraft's dynamic system, excluding tail propeller, but including wing rotors, clutch, transmissions, shafting and belts is approximately 350 lb.

Wings are low-aspect ratio, using a relatively thick (about 21%) airfoil having a modified NASA 4421 section. The NASA section was retained on the upper portion of the airfoil, the lower section being modified to provide a flat bottom exit on the ducts. Wing consists of two outboard panels bolted to a center section. Main rotors and their transmissions are supported within the ducts by four stators attached to the duct periphery. The duct is of aluminum alloy sheet stiffened by channel-type rings to which contour-type ribs are attached. Duct wall depth is about 18 in.; including lips, depth is approximately 24 in.

After considerable study as to the type of closures that could be used to close the ducts during the high-speed forward flight phase, Vanguard decided upon a single large cover plate, raised and lowered by hydraulic actuators, atop the wing and spring-loaded Venetian-blind type louvers on the under surfaces. Single-plate top closures are expected to provide a cleaner closure on the curved upper wing surface than would a series of louvers; other benefits expected are that the raised lid will provide some lift when ducts are open and also give a venturi effect to the air as it comes over the lips of the ducts. Optimum vertical positioning of the lids will be among the data sought during the tunnel trials.

Single-plate type covers are also expected to ease problems encountered in relative positions of center of lift of the wing and duct and the center of pressure movement of the duct caused during transition into high-speed forward flight.

Circular Planform

In the Vanguard 2, a wing approaching a circular planform was chosen because of characteristic location of the aerodynamic center near the 50% chord, permitting use of larger rotors requiring less power. The usual movement forward of the center of lift, when the aircraft moves forward when rigid rotors are utilized, is largely overcome by use of hinged rotors.

As forward speed is increased in this aircraft, it is expected that the lift generated on the duct cover plates and other fixed areas will permit reduction of pitch of the rotor blades and reduction of inflow over the duct lip, thus obviating the large pitching moment normally generated by increased flow over duct forward lips.

Decrease in blade pitch is made until the aircraft reaches a forward speed of approximately 50 mph., at which time the wing rotors are declutched. The tail pusher propeller takes over propulsion load and cover plates are closed top and bottom.

Normal VTOL operational procedures consist of starting the engine with main rotors declutched and tail propeller in low pitch. Wing closures are opened, clutch is engaged and collective pitch is increased in main rotors to hover. Vertical ascent is made to clear obstacles and tail propeller pitch is increased for translation into forward flight. As transition speed is reached, the main rotor collective pitch is decreased, closures are retracted and the wing takes full aerodynamic load. Main rotors are declutched.

In hovering, roll control will be achieved by differential pitch changes in the wing fans. Pitch and yaw control is achieved by rudder and elevator movement. The shrouded pusher propeller, which is identical in design to the wing

2C Specifications

General dimensions	
Over-all span	22 ft.
Over-all length	25 ft. 6 in.
Over-all height	7 ft. 9 in.
Wing data	
Airfoil section	NASA 4421 modified
Total wing area	210 sq. ft.
Dihedral	7½ deg.
Incidence	3 deg.
Aileron span	5 ft. 11 in.
Aileron chord	20 in.
Aileron area	20 sq. ft.
Wing ducted rotors	
Blade diameter	6 ft. 6 in.
Number of blades	3
Solidity	.095
Tip speed	900 fps.
Blade chord	3.75 in.
Airfoil section	NASA 0009
Tail data	
Duct ring diameter	5 ft.
Duct ring chord	14 in.
Stabilizer area	17 sq. ft.
Elevator area	10 sq. ft.
Fin area	8 sq. ft.
Rudder area	8 sq. ft.
Landing gear	
Tread	6 ft. 5.5 in.
Wheelbase	10 ft. 2 in.
Tipover angle	38 deg.
Main wheels	6.00 x 6
Weights	
Gross weight	2,200 lb.
Empty weight	1,700 lb.
Useful load	500 lb.
Performance (estimated)	
Maximum speed	190 mph.
Cruise speed (70% power)	165 mph.
Vertical rate of climb @ sea level (standard day)	500 fpm.
Maximum rate of climb @ sea level (standard day)	1,000 fpm.
Endurance	1 hr.
Powerplant	
Make, type and power	1 Lycoming O-540-A1A @ 265 hp.

(right) Navy Polaris AX-1 flight test vehicle at beginning of launch. Lockheed's Polaris fleet ballistic missile is more than a year ahead of original schedule.

(below left) 44-foot shock tube—the fastest and hottest tunnel in private industry—can produce speeds up to Mach 22 and temperatures of more than 12,000°F.

AERODYNAMICS

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An important aspect of Lockheed's basic research and development is the systems approach to optimum flight performance by means of computer simulation of missile airframe, autopilot and guidance characteristics.

Other studies are being made in the problems of lunar and planetary probes and man-in-space.

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rotors except for a smaller diameter, is expected to provide adequate pitch and yaw stability by virtue of providing a long moment arm. Aircraft control in forward flight will be attained by use of rudder, elevators and ailerons.

Propulsive force of the tail propeller during hovering flight will be offset by a three-degree rearward tilt of the wing fans, inherent in the three-degree wing incidence.

Directional control will be by means of adjustable pedals and cables to the rudder horn. Longitudinal pitch control consists of a cyclic stick and cables to the elevator horn; roll and collective systems are mixed by a differential bellcrank assembly. The collective stick has a twist grip for operating the throttle. The cyclic stick is connected through the differential bellcranks to both ailerons and collective pitch change on the wing fans. Ailerons are operable at all times, although their effectiveness will be practically nil at low speeds. Tail propeller pitch is controlled by a switch on the cyclic stick grip, energizing an electric actuator in the tail cone. The fuselage will retain a level attitude during all operational phases—hovering, transition and forward flight—within plus or minus three degrees.

PRIVATE LINES

Starting June 1, civil aircraft and civil aviation equipment will be removed from the U. S. Munitions List administered by the State Department, and will be licensed for export by the Commerce Department's Bureau of Air Commerce. A general licensing arrangement will permit aircraft registered in foreign friendly countries to take on supplies, equipment and spares required for normal operation.

Canadian Business Aircraft Operators is newly formed organization for companies employing professional pilots. First national chairman is John R. Martin, chief pilot for Canadian Breweries, Ltd. Mail address of COPA is: Box 734, Ottawa, Ont.

Chinese communists plan to make use of aerial photography in their program for rebuilding the capital city of Peking, in order to speed its completion, scheduled for this fall. Peking radio noted that Chinese Communists increased use of civil aircraft by 76.6% last year compared with 1957.

Douglas Super B-26 executive transport has been delivered by L. B. Smith Aircraft Corp. to G. C. Murphy Co.'s Allegheny County (Pa.) Airport base. Firm has more than 414 variety stores from the East Coast to the Mississippi.

WHO'S WHERE

(*Continued from page 23*)

Changes

E. Gilbert Mason, director of research, development, design and marketing, The Hardman Tool and Engineering Co., Los Angeles, Calif.

William T. Caldwell, marketing manager, American Missile Products Co., Lawndale, Calif.

Guilford L. Hollingsworth, director, Boeing Scientific Research Laboratories, Seattle, Wash.

Michael V. Sullivan, manager, Reconnaissance Laboratory, Research and Development Division of Military Electronic Operations, Allen B. Du Mont Laboratories, Inc., Clifton, N. J. Mr. Sullivan succeeds **John S. Auld,** appointed director, Military Programs Division of Military Electronic Operations.

C. M. Whitley, manager and **H. J. Jennings,** assistant manager, Aerojet-General Corp.'s newly established Los Angeles, Calif., office.

Robert W. Meals, technical representative for Hercules Powder Co.'s Chemical Propulsion Division at Redstone Arsenal, Huntsville, Ala. **Richard Winer** succeeds Mr. Meals as assistant manager of Allegany Ballistics Laboratory, Cumberland, Md.

William A. Kinnaman, manager-sales, General Electric's Light Military Electronics Department, Utica, N. Y.

Government & Industrial Research, Philco Corp., Philadelphia, Pa., has announced the following appointments: **Chester P. Woodward,** assistant director of research; **Dr. Robert B. Goldman,** manager of sensory and data handling systems; **Stanley Zebrowitz,** manager of military communications research.

Dr. Italo S. Servi, director of research, Metals Division, Kelsey-Hayes Co., New Hartford, N. Y.

Richard A. Kirk, chief project engineer, Tamar Electronics, Inc., Los Angeles, Calif.

Robert O. Bullard, consultant-defense business evaluation, General Electric's Defense Evaluation Operation, Washington, D. C.

Lt. Gen. Stanley R. Mickelsen (USA, ret.), technical adviser, Hughes Aircraft Co.'s Ground Systems Group, Fullerton, Calif. Also: **Dr. Robert D. Teasdale,** head-systems analysis department, Ground Systems Group.

Russell C. Galbraith, assistant general manager, Lockheed Electronics and Avionics Division, Los Angeles, Calif.

Capt. Edward M. Owen (USN, ret.), manager of Grand Central Rocket Co.'s Washington, D. C., office.

Douglas Aircraft Co., Inc., Santa Monica, Calif., has announced the following appointments in missiles and space systems engineering: **G. V. Butler,** chief project engineer-space systems; **T. J. Gordon,** project engineer-NASA and Able; **W. L. Tietjen,** project engineer-Discoverer; **R. W. Hallet, Jr.,** staff assistant to the chief engineer in space systems activities.

James E. Colburn, director-flight engineering and technical procedures, Continental Air Lines, Inc.

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Aeromed Facility Studies Shock Absorber Seats for Jet Passengers

Hydraulic shock absorber system whereby passengers in jet transports would be able to survive fairly high impact accelerations was proposed to the Aeromedical Assn.'s 30th annual meeting by James J. Ryan, University of Minnesota professor, and Col. John P. Stapp, chief of the Aeromed Laboratory at Wright Air Development Center.

Working from loads and accelerations data obtained by Cornell Automotive Crash Injury Research in deliberate automobile crashes involving tests of hydraulic bumper-shock absorbers, values were projected into aircraft situations to derive design parameters for the safety equipment.

Seat belt experiments with humans indicated a safe tolerance of 23 g and a structure and seat belt to restrain a person would be required to carry a force of about 4,000 lb. While such a seat and supporting structure may require an increase in strength from those presently designed, a proper approach should allow adequate design for strength without appreciable weight increase. The seat belt should be as rigid as possible to prevent elongation and springback.

Shock Absorbers

Type of hydraulic shock absorber applicable for air transport crash protection would be modified to exert a constant force of about 4,000 lb. per individual when deceleration exceeded about 23 g. Thus, a 6-in. stroke absorber would allow an applied force equal to a deceleration of 33 g for a time of 0.055 sec. without the individual sensing more than 23 g. If absorber stroke were lengthened to 2 ft. instead of 6 in., deceleration time would be doubled for the same response, according to Stapp and Ryan.

With an average force of 23 g applied to an airplane during a crash landing at 105 kt., the plane would stop in 21 ft. in a time of approximately ½ sec. At 210 kt., the distance would be 84 ft. and the time ½ sec. Since most crashes occur over much greater distances, time interval of extreme deceleration greater than the foregoing values, would be very short, and the absorber would alleviate the excess.

Primary method of applying hydraulic cylinder shock absorbers on air transports to decelerate passengers on a crash would be by connecting the absorbers to rails on which seats are mounted and allowing the assembly to slide along on the floor.

For a jet transport, a 3-in. dia. tube assembly some 30 in. long would retard with a force of nearly 4,000 lb. (23 g) for each of between 15 and 20 seats (80,000 lb. maximum). In a series of three persons seated side by side, two sets of three absorbers would protect two sections totaling approximately 100 passengers. Absorbers would be made any size to meet space and loading requirements, and the use of high strength metal would reduce the weight below 20 lb. each.

Seat Fittings

Seat fittings, Stapp and Ryan indicated, would require attachment of the feet to tension bars capable of sliding under excessive loads in a slot formed by a floor channel, which would be part of floor structure and would carry transverse loads from each seat to the fuselage.

The absorber would limit impulse loads during a crash to tolerable limits of the seat belt. Retracting springs may be desirable to recycle absorbers during impact if momentary reductions in intensity may possibly occur.

Application of high absorber forces to the airplane structure would require attach point reinforcements and means of distributing the added load from the rear section to the forward area.

Second method of applying hydraulic absorbers for controlled attenuation is on the immediate structure to which the seat belt is attached. This way, each seat would have a limiting absorber which would operate whenever impact forces exceed a set value. This could be accomplished by using the absorber itself as rear legs of the combined seat. Rotation would be about the front legs, and although a kinematic motion is required in allowing the body to move forward, the rotational inertia would force operation of the absorber element.

Since all seats in the airplane would be subject to the same loads at the same time all would rotate simultaneously to preserve clearance between passengers and the seat ahead.

Design of hydraulic energy absorbers to act only at certain limiting force requires a pressure sensing diaphragm to open restrictive orifices. Units would be permanently sealed to eliminate maintenance, and would be constructed for this application only.

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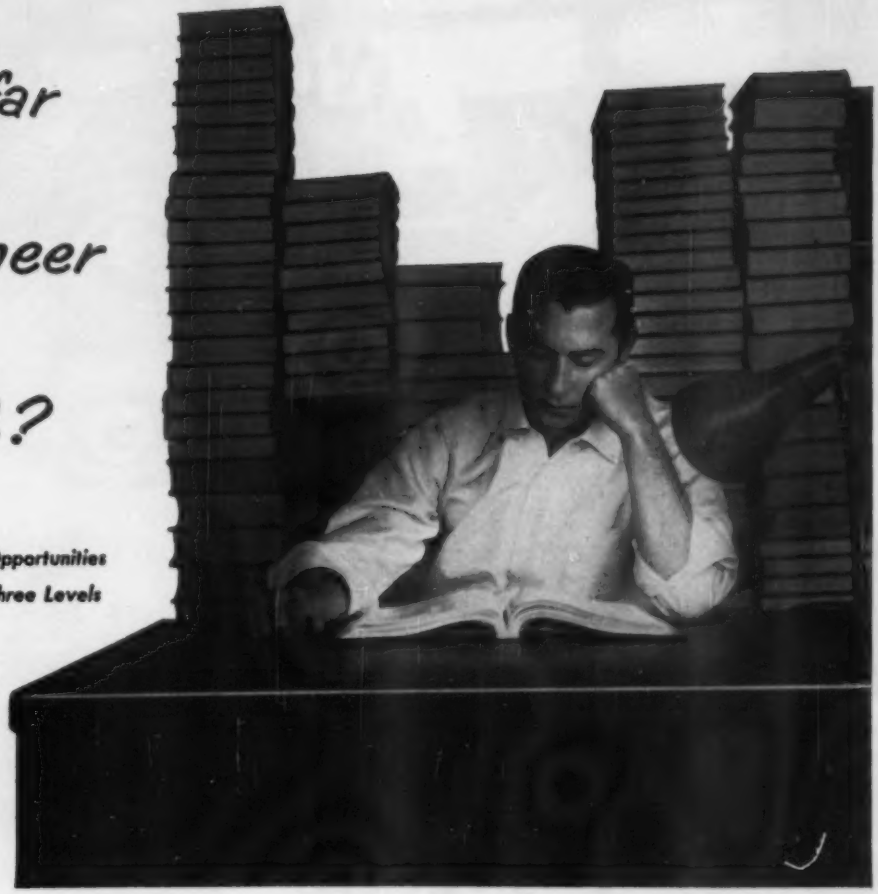

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GENERAL ELECTRIC

COURT STREET, SYRACUSE, N. Y.

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ENGINEERS

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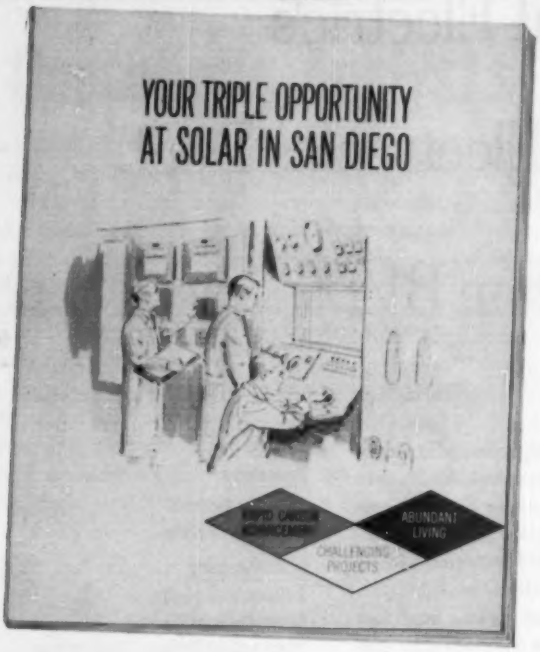

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ENGINEERS

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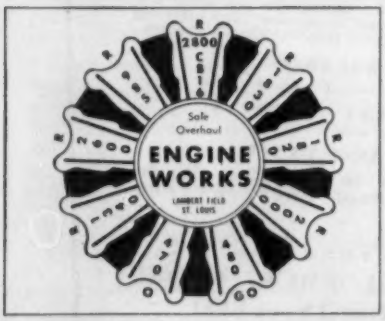

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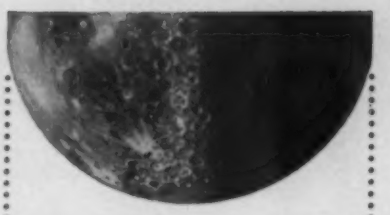

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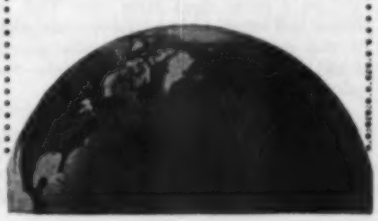

LETTERS

Bouquet

As an oftime vociferous and outspoken critic of your editorial policies from time to time, please permit me to change hats and congratulate you on the fair and equitable manner in which you have made space available in your "Letters to the Editor" section for discussion of the editorial on Rewards and Responsibility (AW Feb. 16).

Ed Modes, Director
Public Relations
Air Line Pilots Assn.
Chicago, Ill.

Brickbat

I agree with Capt. Blanchard (AW May 4, p. 214) and I am afraid that we have taken just about enough. Please cancel my subscription to Aviation Week immediately.

Clarence N. Sayen, President
Air Line Pilots Assn.
Chicago, Ill.

Jet Captain

In the Letters' section, p. 170, of your April 13 issue of Aviation Week you published a letter entitled "Money-Mad Philosophy." Inasmuch as this letter was directed toward me, I must answer for fear that some of my acquaintances or future passengers might believe the misinformation contained therein and might feel that it is applicable to me.

First of all, who am I? I am one of those—to paraphrase your anonymous letter writer—elderly senior captains who is forcing himself on the jets for prestige and increased salary. By what right do I force myself on the jets? Primarily by the right of superior experience. I am an M.I.T. graduate, a Navy trained pilot, a former copilot of prewar B-314 transatlantics flights, a captain of Commodores, C-47s, C-54s, C-87s, L-49s, L-749s, B-377s, DC-7s, and now an FAA rated pilot on Boeing 707-121 series.

What have I had to do to "force" myself into this position? I have had to spend some four weeks (of my time off) in an intensive ground school course on the 707-120, and take written examinations thereon. I have had some 17 hr. of actual flight training on the 707 culminating in a flight check by an FAA flight inspector. I have had five transatlantic round trips on the 707 acting as observer and pilot (I've only been flying the Atlantic as captain since 1945), and this weekend I must demonstrate my ability to fly and knowledge of the 707 on a route check from New York to Rome and return for a company chief pilot. If this route check is successfully passed, I will then be one of the early regular line pilots to fly the 707.

And now, my anonymous copilot friend, your choice of the word "forced" leads me to believe that I have deprived you of this "prestige and increased salary" on the jets. The job is there, and it is up to the company to fill it. The question the company must decide is, should it be you, or should it be me?

I would presume from your disgruntled attitude that you have demonstrated your ability to one of the military services to fly their jets in the wild blue yonder for some two to three hundred hours; and, from your dire predictions of things to come, that this has taken the ultimate in your aeronautical skill.

Let me tell you about the skills required to fly the 707 in scheduled transatlantic service.

First, as to the physical skills required to fly the 707. The 707 is an airplane and must be flown as such. But it is more than just another airplane. I'd like to liken it to a high-spirited horse. As long as you ride it with a tight rein and as the "book" requires, she will give you a lovely ride, but don't take your eyes off her for if you do she is liable to bite you in the leg or kick you in the ——. But these skills are only a small part of the skills required in scheduled transatlantic flying. The success or failure of scheduled transatlantic flights will depend upon your judgment and knowledge of en route procedures, your cruise control, your estimate of en route forecasts, winds, temperatures, tropopause, your noise abatement procedures, etc., just to mention a few items. What is your aptitude, and what is your experience on such items?

As to the captain who could not qualify on jets being made a permanent copilot, I know of no such case, but should it be so then I'd say hurrah for the company for preventing unqualified captains "forcing" themselves on the jets and hurrah for the ALPA for requiring three pilots on jet aircraft.

James B. Magenis
A Transatlantic Captain
Manhasset, N. Y.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Not Inability

In a letter ("Money-Mad Philosophy") published in the April 13 issue of Aviation Week, p. 170, there is the statement, "Besides, in most airlines if the captain with years of flying cannot qualify as a captain on the jet aircraft, etc., they just make him permanent copilot. (This has already been done in the case of PAA jet operation.)"

As the one charged with the responsibility for pilot training in the Atlantic Division of PAA, I should like to correct this defamation of ability of the five supervisory captain pilots who did not fly in command during our early Boeing 707 operation. The assignment as first officer of these men was caused solely by limitations of aircraft availability for training within the time limits imposed by our inauguration of jet service on the Atlantic, and in no case was caused by a pilot's inability to qualify as captain on the 707. It would be extremely unfair to these individuals to let this situation reflect unfavorably on their reputation, for they are all fine pilots and have contributed much to our pioneering jet operation.

William W. Moss
Ass't. Chief Pilot, Training
Atlantic Division
Pan American World Airways

Morale Booster

After reading your fine article regarding the aero clubs of the Strategic Air Command (AW April 13, p. 113), we, the members of the Loring AFB club, thought the readers of Aviation Week would be interested in details concerning our organization.

Geographically, Loring lies three miles due west of New Brunswick, Canada, in Maine's northernmost county, Aroostook. This location makes it necessary for us to use skis on our aircraft as landing gear from early November to late March. Plus, it enables us to gain experience in flying over "foreign" lands.

Our club has a membership totaling approximately 135 members, which is further broken down into qualified personnel and student personnel. At present we have 52 students, including one female dependent, attending our twice-weekly ground school held in the evenings.

This entire group logs over 2,500 hr. of flying time a year.

To ensure that each member can get an adequate amount of flying time we have a fleet of four Aeronca Champions for private instruction; one Fairchild 24 which is utilized by our hunters and fishermen; two Beechcraft T-34 Mentors on loan from the government; two Cessna 172s used for radio checkouts and short cross countrys; one Cessna 182 and one Piper Comanche which serve as our long cross-country aircraft.

The qualified pilots fly out of Loring itself while our student pilots use Caribou Municipal Airport which is about 11 mi. from the base.

We fly under stringent safety rules which are set down for us by the Base Flying Safety Officer.

All our flying techniques are completely standardized just as they are for the military pilots.

It is our belief that our organization has a three-fold advantage: that of boosting the morale in a rather remote area; that of being of service to the community in time of emergency; and lastly, stimulating aviation interest by actual participation. Thus our members not only serve their country, but the sphere of aviation itself.

Lt. William C. Rolle, Jr.
Public Relations Director
SAC Aero Club
Loring AFB, Me.

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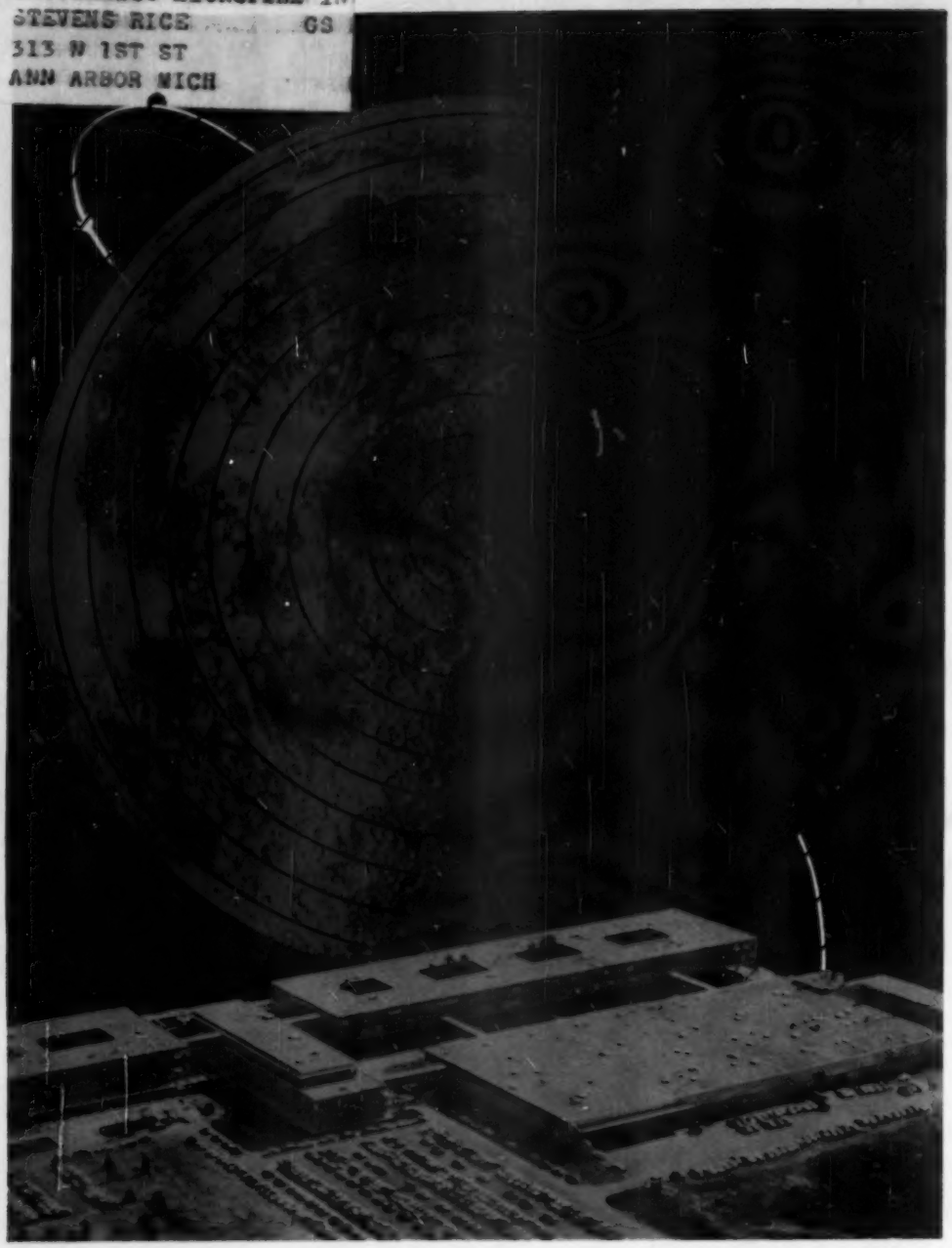

Space age research gets a new headquarters—One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted in areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space.

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